THE

MANITOBA

BRIDGE & IRON WORKS

LIMITED

WINNIPEG — CANADA

CATALOGUE

1927

ALBERTA AND BRITISH COLUMBIA
518 Lancaster Building
CALGARY

SASKATCHEWAN
510 Westman Chambers
REGINA

Catalogue "F"

· 1927 ·

Structural and Fabricated

STEEL *and* IRON

FOR

Architects - Contractors - Manufacturers

STEEL STRUCTURES
BUILDINGS—*Offices - Warehouses - Industrial Plants*
BRIDGES—*Railway - Highway - Pontoon - Foot*
TRANSMISSION TOWERS - WATER TANKS

PLATE AND TANK CONSTRUCTION
TANKS *for Gas - Oil - Water - Air*
SPECIAL CATALOGUE FURNISHED ON REQUEST
PLATE WORK—*Bins - Hoppers - Chutes - Stacks*

CASTINGS
GREY IRON - STEEL - SEMI STEEL

FORGINGS
UPSET RODS - CONTRACTORS' REQUIREMENTS
COMPLETE CONSTRUCTION LINE

COAL MINING EQUIPMENT
TIPPLES - CAR HAULS - SCREENS
AIR CLEANING EQUIPMENT - PORTABLE CONVEYORS

CONTRACTORS' SUPPLIES
DERRICKS - BUCKETS - DUMP CARS
PILE SHOES AND CAPS - SCRAPERS

TRANSMISSION AND CONVEYING MACHINERY
SPECIAL CATALOGUE FURNISHED ON REQUEST

STOCKS
LARGE STOCKS OF STRUCTURALS, PLATES AND BARS

The
MANITOBA BRIDGE & IRON WORKS
Limited

Calgary WINNIPEG Regina

The Leading Steel and Iron

THE MANITOBA BRIDGE AND IRON WORKS PLANT AT WINNIPEG

Structural Steel and Iron for Bridges and Buildings
Steel Tanks and Manufactures of Plate
Mining Equipment Grain Elevator and Transmission Machinery
Grey Iron Castings Forgings and Pressed Work
Railway Frogs, Switches and Crossings

THE MANITOBA STEEL AND IRON CO. WAREHOUSE AT WINNIPEG

Large Stocks of Steel and Iron Bars, Angles, Beams, Channels, Sheets, Plates, Shafting, Boiler Tubes, Bolts, Nuts, Rivets, Reinforcing Steel, Etc.

ron ndustry of Western Canada

A Quarter of a Century of Service and Growth is the record of the Manitoba Bridge and Iron Works, Limited. Development from a small beginning twenty-five years ago is shown better by these views of its plants and warehouses than by words.

THE MANITOBA ROLLING MILLS PLANT AT SELKIRK
Capacity: 25,000 Tons per annum of New Billet Basic Open Hearth Steel
Products include Merchant Bars, Forging Bars, Concrete Reinforcing—
Plain and Deformed, Manufacturers' Special Sections.

IN THIS BRIEF SPACE it is impossible to give in detail a picture of our many activities, but the following pages, if carefully studied, will afford the reader many surprises concerning the quality, volume and variety of our products, and the many lines of building and manufacturing in which we are engaged.

The MANITOBA BRIDGE AND IRON WORKS
LIMITED

Plants:
WINNIPEG
AND
SELKIRK

Head Office:
WINNIPEG

Branches:
CALGARY
AND
REGINA

Announcement

THIS COMPANY, owned and controlled by Western Canadian capital, has been serving its patrons of the West for a quarter of a century. Commencing twenty-five years ago with a foundry, forge, machine and boiler shop, its progress throughout the years has been practically uninterrupted and at this time additional buildings and departments, comprising bridge and structural, frog and switch, galvanizing, tank, bolt and rivet manufacturing all combine to make it the most comprehensive industry of its kind west of Toronto.

Such growth in a few years, despite the post war depression, was only made possible by the production of first-class goods and the rendering of such service to our new patrons as has made them permanent customers.

Our interests are so interwoven with the welfare of the whole West that we must be able to advise the trade with respect to the best engineering practice in all lines, and to this end maintain a corps of engineering specialists well versed in the different branches.

Branch offices are maintained at Regina and Calgary for the convenience of our many friends.

As large stocks of various grades of steel are stored at our Winnipeg yards, immediate needs can be satisfied at once.

With such a range of manufacturing coupled with capable engineering direction we feel that we are well justified in seeking your business, and invite your inquiries and problems, all of which will be promptly and carefully treated.

THE MANITOBA BRIDGE & IRON WORKS, LIMITED
WINNIPEG

No. 1—Interior of the Structural Shops of The Manitoba Bridge and Iron Works, Limited

STRUCTURAL STEEL WORK

No. 2—Loft Building, in Winnipeg's Business Section, Fabricated and Erected by the Manitoba Bridge and Iron Works, Limited.

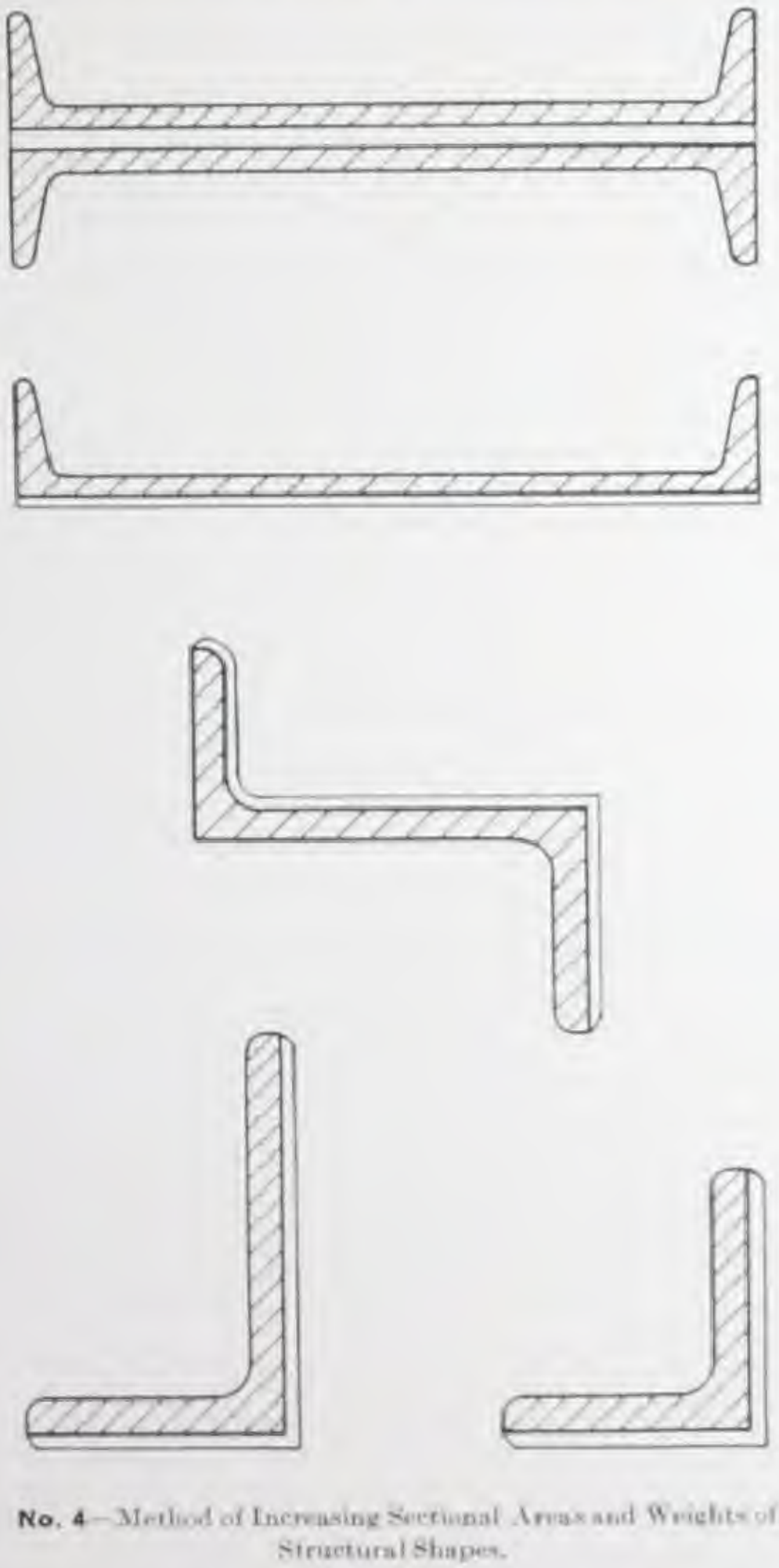
The satisfactory service accorded to our customers on contracts which involve the use of structural steel is the result of almost twenty years of specialization in this line, aided by complete equipment to fill the most complicated order.

No. 3—Railway Locomotive Shops, Fabricated and Erected by The Manitoba Bridge and Iron Works, Limited

STRUCTURAL STEEL

The steel used in structures is in the form of single sections or in combination of two or more sections.

These sections may be in any of the following shapes: square and round bars, flat bars, plates, channels, angles, I-beams, H-sections, zees and tees. Flat bars more than six or seven inches wide are termed plates.



No. 4—Method of Increasing Sectional Areas and Weights of Structural Shapes.

Structural shapes are rolled to a minimum sectional area and the method of increasing the area and weights is shown in the cuts. The hatched portion represents the minimum section, the blank portion the added areas. In case of channels and beams, the enlargement of the section adds an equal amount to the thickness of the web and width of flanges. In the case of angles and zees the effect is to increase slightly the length of the legs.

Beams and Channels—The properties of standard sections are the same, irrespective of the source of manufacture, but different manufacturers have special sections which they roll for particular purposes. Standard I-beams are rolled in depths of from 3-inch to 24-inch, and channels from 3-inch to 15-inch. Lengths of beams are from 3-inch to 10-inch consecutively, then 12-inch, 15-inch, 18-inch, 20-inch and 24-inch. For channels 3-inch to 10-inch consecutively, then 12-inch and 15-inch. For each depth of beam or channel there are several standard weights.

The sizes usually carried in stock are the minimum weights shown in the tables but in the larger sizes two weights are usually carried.

Standard Carried in Stock

Beams			Channels		
Size, In.	Weight per Foot, Lbs.		Size, In.	Weight per Foot, Lbs.	
3	5.7	7.5	3	4.1	
4	7.7	10.5	4	5.4	
5	10.5	14.75	5	6.7	
6	12.5	17.25	6	8.2	13.0
7	15.3	20.4	7	9.8	17.25
8	18.4	23.6	8	11.5	16.25
9	21.9	26.0	9	13.4	
10	25.4	29.4	10	15.3	25.0
12	31.5	40.8	12	20.7	30.0
15	42.9	50.4	15	33.9	50.0
18	54.7	70.0			
20	65.4	83.4			
24	79.9	100.0			

In addition to the sizes all the sections shown in the tables can be supplied for a reasonable allowance of time must be given to procure sections from the mill.

H-Sections—H-sections as shown in the tables from 4-inch up to 8-inch are all carried in stock and are rolled by the Carnegie Steel Company.

The larger sizes from 8-inch up to 14-inch are usually carried in stock in their minimum weights and other weights to give a gradual increase in area up to the largest sizes. All sizes over 8-inch are rolled for the Bethlehem Steel Company, although the Carnegie Steel Company are now preparing to roll larger sections.

H-Sections Usually Carried in Stock

Nominal Size, In.	Weight per Foot, Lbs.					
4	13.0					
5	14.0					
6		24.0				
8	35*	32.0	18.0*	34.0	47.0*	28.0
10	89	54				
12	64.0	74.0	28.0			
14	82.0	89	90	114.0		

The large range in weights of the 8-inch sections is due to the fact that this size is rolled by both Carnegie Steel Company and Bethlehem; the sizes marked with an asterisk (*) being Carnegie principle, the others Bethlehem.

The Bethlehem Steel Company also roll H-beams in larger weights than shown in all sizes up to 14-inch x 287.5 lbs. per foot but these are only for special conditions. It is usual however, where an extra heavy column is required, to use one of the standard weights and bring it up to the required area by using rivetted cover plates.

Bethlehem Beams and Girders—These differ from manufacturers' standard sections rolled by other manufacturers. The beams have heavier flanges and lighter webs. The girders are the strongest sections rolled, for their depth, but are uneconomical where there is room for a deeper section. Tables showing properties and loading are given in the Bethlehem Handbook.

Angles, Tees and Zees-Angles are carried in stock in all sizes from ½-inch square up to 8-inch square and in all thicknesses from ⅛-inch up to 1-inch both in equal and unequal legs.

Up to 3-inch angles, the thickness varies by 1/16-inches, and weights are carried up to ⅜-inch thick. Over 3-inch to 5-inch, thicknesses are from ¼-inch, to ½-inch, varying by 1/16-inches.

From 6-inch to 8-inch, the thickness starts at ⅜-inch and varies by ⅛-inches up to ¾-inch. The above variations are those usually carried in stock.

Tees and zees are used only to a limited extent for special purposes and a few of the commoner sizes only are carried in stock.

Notes about Structural Sections—

Flanges of both standard I-beams and channels have a uniform slope of 16-2/3% equivalent to 2 inches per foot.

For I-beams and channels, the enlargement of the section adds a proportional amount to the thickness of the web and the width of the flanges. All other dimensions remain unchanged.

For angles, the enlargement of the section (by separating the rolls) slightly increases the length of the legs.

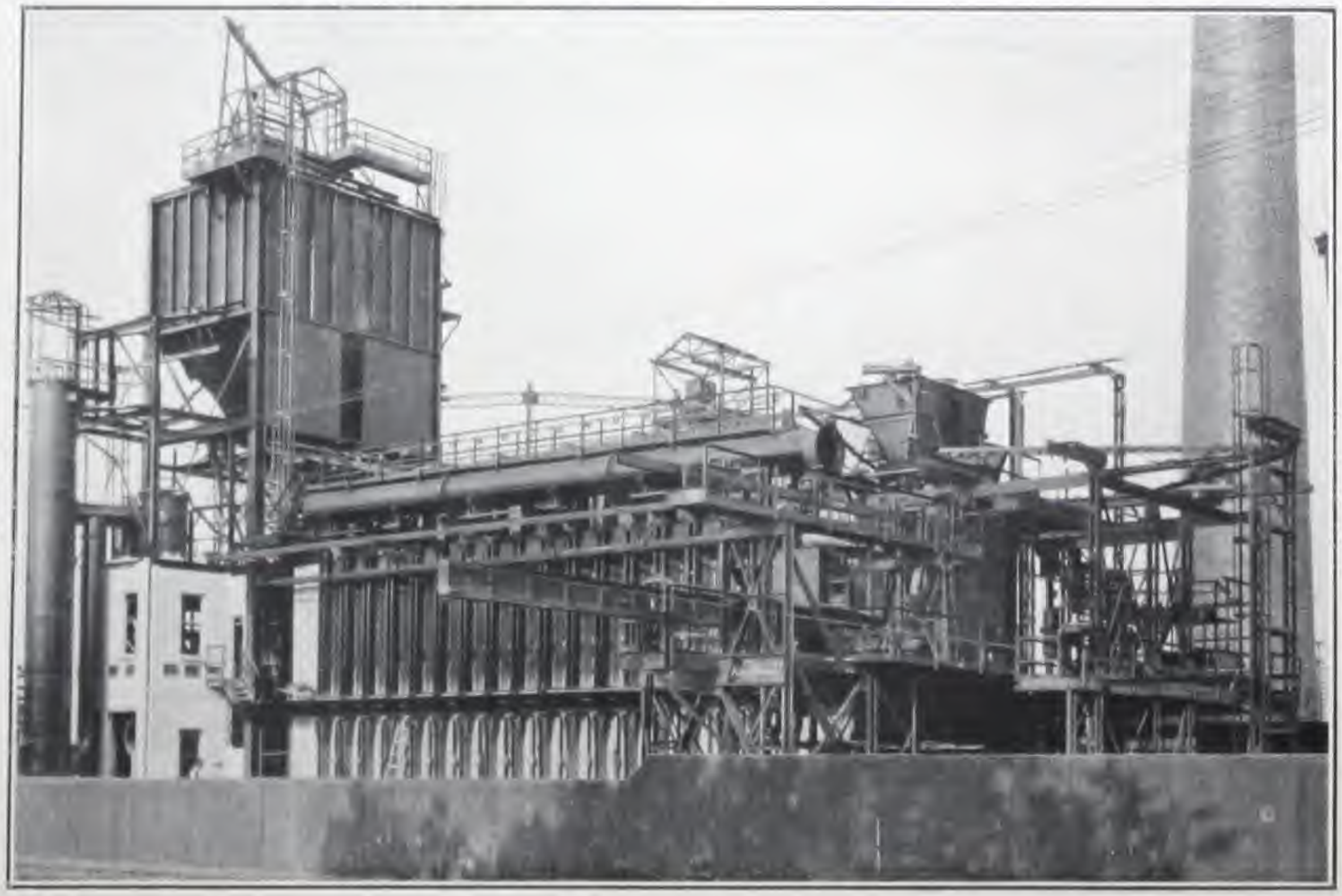
I-beams and channels should be ordered to weights given in the tables. Any weights ordered other than those shown will be furnished and charged for at the next higher weight.

Angles are rolled only to the variation in thickness and weight given in the table.

In ordering, designate either the weight or thickness wanted, but not both.

All structural sections have an allowable variation of 2½% either way from the nominal weight of the section.

All structural sections will be cut to lengths, the extreme variation not exceeding ¾-inch, unless otherwise arranged.



No. 5. — Koppers Coke Plant at the Winnipeg Electric Company's Gas Works, Winnipeg.

The steel and miscellaneous iron work in this building was fabricated by the Manitoba Bridge and Iron Works, Limited, for the Koppers Company of Pittsburg, Pa.

This is an ideal illustration of the industrial steel and iron fabrication in which we specialize.

15

13

29

21

27

14

Depth of Beam
In.

DIMENSIONS, WEIGHTS AND ELEMENTS OF STRUCTURAL BEAMS

Depth of Beam In.	Weight per Foot Lbs.	Area of Section In.²	Width of Flange In.	Thickness of Web In.	Axis 1-1 I In.⁴	Axis 1-1 r In.	Axis 1-1 S In.³	Axis 2-2 I In.⁴	Axis 2-2 r In.	Axis 2-2 S In.³
27	90.0	26.34	9.000	0.524	2858.3	10.60	211.7	73.3	1.69	16.2
24	120.0	35.13	8.048	0.798	3010.8	9.26	250.9	84.9	1.56	21.1
	115.0	33.67	7.987	0.737	2840.3	9.17	236.0	82.8	1.57	20.7
	110.0	32.18	7.925	0.675	2800.1	9.14	233.1	80.6	1.58	20.3
	105.9	30.98	7.875	0.625	2841.3	9.53	234.3	78.9	1.60	20.0
	100.0	29.25	7.247	0.747	2371.8	9.05	197.6	48.4	1.29	13.4
	95.0	27.79	7.186	0.686	2304.5	9.08	191.8	47.0	1.30	13.1
	90.0	26.30	7.124	0.624	2236.1	9.21	185.8	45.5	1.32	12.8
	85.0	24.84	7.063	0.563	2150.8	9.33	180.0	44.2	1.33	12.5
	79.9	23.43	7.000	0.500	2087.2	9.46	173.9	42.9	1.35	12.2
	74.2	21.70	9.000	0.870	1961.1	9.48	192.5	61.2	1.68	12.0
24	60.4	17.68	8.250	0.828	1253.5	8.42	117.7	43.5	1.57	10.6
20	100.0	29.20	7.273	0.873	1648.3	7.51	164.8	52.4	1.34	14.4
	95.0	27.74	7.200	0.800	1599.7	7.59	160.0	50.5	1.35	14.0
	90.0	26.20	7.126	0.726	1550.3	7.68	155.0	48.7	1.36	13.7
	85.0	24.80	7.053	0.653	1501.7	7.78	150.2	47.0	1.38	13.3
	81.4	23.74	7.000	0.600	1466.3	7.86	146.6	45.8	1.39	13.1
	75.0	21.90	6.391	0.641	1263.5	7.60	126.3	30.1	1.17	9.4
	70.0	20.42	6.317	0.567	1214.2	7.71	121.4	28.9	1.19	9.2
	65.4	19.08	6.250	0.500	1168.6	7.83	116.9	27.9	1.21	8.9
18	90.0	26.29	7.236	0.799	1256.5	6.91	139.9	51.9	1.40	14.3
	85.0	24.81	7.154	0.718	1216.6	7.00	135.2	49.8	1.42	14.0
	80.0	23.34	7.072	0.636	1179.8	7.10	130.8	47.9	1.43	13.6
	75.0	22.04	7.000	0.500	1141.8	7.20	126.9	46.3	1.45	13.2
	70.0	20.46	6.251	0.751	917.3	6.70	100.9	24.4	1.09	7.8
	65.0	18.98	6.169	0.669	877.7	6.80	97.5	23.4	1.11	7.6
	60.0	17.50	6.087	0.587	837.8	6.92	93.1	22.3	1.13	7.3
	54.7	15.93	6.000	0.500	795.5	7.07	88.4	21.2	1.15	7.1
	48.2	14.09	7.000	0.350	737.1	7.23	81.9	20.0	1.19	8.11
15	75.0	21.83	6.278	0.868	687.2	5.61	91.6	30.6	1.18	9.8
	70.0	20.38	6.181	0.770	650.6	5.60	87.0	28.8	1.19	9.3
	65.0	18.91	6.083	0.672	632.1	5.78	84.3	27.9	1.20	8.9
	60.8	17.68	6.000	0.588	609.0	5.87	81.2	26.0	1.21	8.7
	55.0	16.08	5.758	0.648	508.7	5.62	67.8	27.0	1.63	8.9
	50.0	14.59	5.649	0.539	481.1	5.74	64.2	26.0	1.65	8.7
	45.0	13.12	5.542	0.432	453.0	5.88	60.5	25.0	1.67	8.4
	42.9	12.47	5.500	0.410	441.8	5.95	58.9	24.6	1.68	8.3
	37.8	10.94	5.250	0.292	405.6	6.09	54.1	19.9	1.35	7.9

DIMENSIONS, WEIGHTS AND ELEMENTS OF STRUCTURAL BEAMS

Depth of Beam	Weight per Foot	Area of Section	Width of Flange	Thickness of Web	Axis 1-1			Axis 2-2		
					I	r	S	I	r	S
In.	Lbs.	In.²	In.	In.	In.⁴	In.	In.³	In.⁴	In.	In.³
12	55.0	16.04	5.600	0.810	319.3	4.46	53.2	17.3	1.04	6.2
	50.0	14.57	5.477	0.687	301.6	4.55	50.3	16.0	1.05	5.8
	45.0	13.10	5.255	0.565	284.1	4.66	47.3	14.8	1.06	5.5
	40.8	11.84	5.250	0.460	268.9	4.77	44.8	13.8	1.08	5.3
	35.0	10.20	5.078	0.428	227.0	4.72	37.8	10.0	0.99	3.9
	31.8	9.26	5.000	0.350	215.8	4.83	36.0	9.5	1.01	3.8
	27.9	8.15	6.000	0.284	199.4	4.95	33.2	12.6	1.24	4.2
10	40.0	11.69	5.091	0.741	158.0	3.68	31.6	9.4	0.90	3.7
	35.0	10.22	4.944	0.594	145.8	3.78	29.2	8.5	0.91	3.4
	30.0	8.75	4.797	0.447	133.5	3.91	26.7	7.6	0.93	3.2
	25.4	7.38	4.660	0.310	122.1	4.07	24.4	6.9	0.97	3.0
	22.4	6.54	5.500	0.252	113.6	4.17	22.7	9.0	1.17	3.3
9	35.0	10.22	4.764	0.724	111.3	3.30	24.7	7.3	0.84	3.0
	30.0	8.76	4.601	0.561	101.4	3.40	22.5	6.4	0.85	2.8
	25.0	7.28	4.437	0.397	91.4	3.54	20.3	5.6	0.88	2.5
	21.8	6.32	4.330	0.290	84.9	3.67	18.9	5.2	0.90	2.4
8	25.5	7.43	4.262	0.522	68.1	3.03	17.0	4.7	0.80	2.2
	23.0	6.71	4.171	0.441	64.2	3.09	16.0	4.4	0.81	2.1
	20.5	5.97	4.079	0.349	60.2	3.18	15.1	4.0	0.82	2.0
	18.4	5.34	4.000	0.270	56.9	3.26	14.2	3.8	0.84	1.9
	17.5	5.13	5.000	0.220	58.4	3.38	14.6	6.2	1.10	2.5
7	20.0	5.83	3.860	0.450	41.9	2.68	12.0	3.1	0.74	1.6
	17.5	5.09	3.755	0.345	38.9	2.77	11.1	2.9	0.76	1.6
	15.3	4.43	3.660	0.250	36.2	2.86	10.4	2.7	0.78	1.5
6	17.25	5.02	3.565	0.465	26.0	2.28	8.7	2.3	0.68	1.3
	14.75	4.20	3.443	0.343	23.8	2.36	7.9	2.1	0.69	1.2
	12.5	3.61	3.330	0.230	21.8	2.46	7.3	1.8	0.72	1.1
	14.75	4.29	3.284	0.494	15.0	1.87	6.0	1.7	0.63	1.0
5	12.25	3.56	3.137	0.347	13.5	1.95	5.4	1.4	0.63	0.91
	10.0	2.87	3.000	0.210	12.1	2.05	4.8	1.2	0.65	0.82
4	10.5	3.05	2.870	0.400	7.1	1.52	3.5	1.0	0.57	0.70
	9.5	2.70	2.796	0.326	6.7	1.56	3.3	0.91	0.58	0.65
	8.5	2.46	2.723	0.253	6.3	1.60	3.2	0.83	0.58	0.61
	7.7	2.21	2.660	0.190	6.0	1.64	3.0	0.77	0.59	0.58
3	7.5	2.17	2.509	0.349	2.9	1.15	1.9	0.59	0.52	0.47
	6.5	1.88	2.411	0.251	2.7	1.19	1.8	0.51	0.52	0.43
	5.7	1.64	2.330	0.170	2.5	1.23	1.7	0.46	0.53	0.40

DIMENSIONS, WEIGHTS, ELEMENTS AND SAFE LOADS OF

H- AND I-BEAM COLUMNS

Safe Loads in Thousands of Pounds

Allowable fiber stress per square inch 13,000 pounds for lengths of 60 radii or under, reduced for lengths over 60 radii. Weights do not include rivets.

Effective Length in Feet	I-Beams					H-Beams								
	8 in.	7 in.	6 in.	5 in.	4 in.	8 in.			6 in.			5 in.	4 in.	
	18.4 lbs.	15.3 lbs.	12.5 lbs.	10.0 lbs.	7.7 lbs.	37.7 lbs.	34.4 lbs.	31.4 lbs.	20.7 lbs.	17.1 lbs.	14.6 lbs.	14.8 lbs.	12.8 lbs.	
3	69 3	57 5	46 0	37 3	28 5	143 0	130 0	123 6	100 9	91 1	86 2	71 1	51 9	
4	69 3	56 7	44 4	33 5	24 0	143 0	130 0	123 6	100 9	91 1	86 2	71 1	51 9	
5	63 3	49 9	38 3	28 2	19 5	143 0	130 0	123 6	100 9	91 1	86 2	71 1	50 5	
6	55 7	43 1	31 3	22 9	15 3	143 0	130 0	123 6	100 9	91 1	86 2	71 1	45 5	
7	48 1	36 2	26 2	18 0	12 0	143 0	130 0	123 6	100 9	91 1	86 2	65 6	40 4	
8	40 5	30 4	22 1	15 3	10 2	143 0	130 0	123 6	95 1	86 7	82 5	60 1	35 3	
9	33 7	26 5	19 2	13 6	9 3	143 0	130 0	123 6	88 5	80 9	77 1	54 6	30 3	
10	27 8	23 4	16 7	11 9	8 3	136 9	126 0	120 5	82 0	75 1	71 7	49 1	26 6	
11	23 5	19 9	14 6	9 9		129 7	119 6	114 5	75 4	69 3	66 2	43 7	23 0	
12	20 2	16 5	10 8			122 5	113 2	108 5	68 9	63 5	60 8	38 2	21 3	
13	17 6	13 7				115 3	106 8	102 5	62 4	57 6	55 4		19 4	
14	15 4					108 1	100 4	96 5	55 8	51 8	49 9		17 4	
15						100 9	93 9	90 4	51 9	47 8	46 0		15 8	
16						93 7	87 5	84 4	48 3	44 6	42 9			
17						86 4	81 1	78 4	45 0	41 7	40 1			
18						79 2	74 7	72 4	42 0	38 9	37 5			
19						72 1	68 2	66 4	39 2	36 3	34 9			
20						65 0	62 0	60 3	36 5	33 8	32 6			
21						57 9	55 8	54 3	33 8	30 1	29 3			
22						50 8	49 7	48 3	30 2	26 9	26 1			
23						43 7	43 6	42 4	26 5	23 7	22 9			
24						36 6	37 5	36 4	22 9	20 4	19 8			
25						29 5	31 4	30 4	19 2	17 2	16 6			
26						24 5	26 4	25 4	15 6	14 0	13 5			
27						23 7	23 6	22 4						
28						22 9	20 8	19 4						
29						22 0	17 9	16 4						
30						21 2	15 0	13 5						
Area, in.²	5.34	4.43	3.63	2.92	2.23	11.08	10.08	9.230	6.090	5.031	4.298	3.47	2.651	
I x-x, in.⁴	66.9	56.2	45.8	36.2	26.0	120.8	113.3	112.8	47.4	43.1	44.6	23.8	10.7	
r x-x, in.	3.29	3.56	3.62	3.52	3.41	3.31	3.35	3.49	2.79	2.93	3.22	2.62	2.01	
I y-y, in.⁴	3.86	2.77	1.86	1.20	.77	39.8	38.1	34.2	15.7	14.7	14.2	7.6	3.6	
r y-y, in.	0.848	0.790	0.716	0.643	0.588	1.89	1.94	1.93	1.62	1.71	1.82	1.48	1.17	
Weight, Lbs. per Foot	18.4	15.3	12.5	10.0	7.7	37.7	34.3	32.0	20.7	24.1	22.8	19.8	13.8	

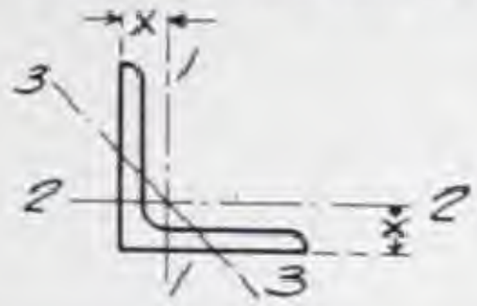
Safe load values in "light" type are for ratios of $\frac{l}{r}$ not over 60; in "**heavy**" type are for ratios up to 120 $\frac{l}{r}$; in "*italic*" type are for ratios not over 200 $\frac{l}{r}$.

DIMENSIONS, WEIGHTS AND ELEMENTS OF STRUCTURAL CHANNELS

American Standard Sections

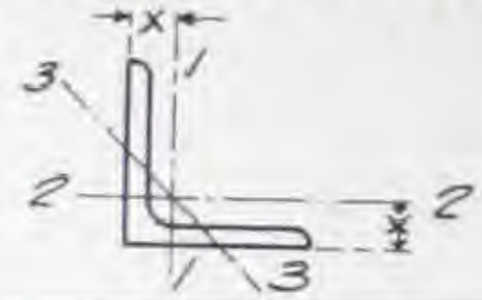
Depth of Channel	Weight per Foot	Area of Section	Width of Flange	Thickness of Web	Axis 1-1			Axis 2-2			
					I	r	S	I	r	S	y
In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.	In.^{3}	In.^{4}	In.	In.^{3}	In.
15	55.0	16.11	3.814	0.814	429.0	5.16	57.2	12.1	0.87	4.1	0.82
	50.0	14.64	3.716	0.716	401.4	5.24	53.6	11.2	0.87	3.8	0.80
	45.0	13.17	3.618	0.618	373.9	5.33	49.8	10.3	0.88	3.6	0.79
	40.0	11.70	3.520	0.520	346.3	5.44	46.2	9.3	0.89	3.4	0.78
	35.0	10.23	3.422	0.422	318.7	5.58	42.5	8.4	0.91	3.2	0.79
	33.9	9.90	3.400	0.400	312.6	5.62	41.7	8.2	0.91	3.2	0.79
12	40.0	11.73	3.415	0.755	196.5	4.09	32.8	6.6	0.75	2.5	0.72
	35.0	10.26	3.292	0.632	178.8	4.18	29.8	5.9	0.76	2.3	0.69
	30.0	8.79	3.170	0.510	161.2	4.28	26.9	5.2	0.77	2.1	0.68
	25.0	7.32	3.047	0.387	143.5	4.43	23.9	4.5	0.79	1.9	0.68
	20.7	6.03	2.940	0.280	128.1	4.61	21.4	3.9	0.81	1.7	0.70
10	35.0	10.27	3.180	0.820	115.2	3.34	23.0	4.6	0.67	1.9	0.69
	30.0	8.80	3.033	0.673	103.0	3.42	20.6	4.0	0.67	1.7	0.65
	25.0	7.33	2.886	0.526	90.7	3.52	18.1	3.4	0.68	1.5	0.62
	20.0	5.86	2.739	0.379	78.5	3.66	15.7	2.8	0.70	1.3	0.61
	15.3	4.47	2.600	0.240	66.9	3.87	13.4	2.3	0.72	1.2	0.64
9	25.0	7.33	2.812	0.612	70.5	3.10	15.7	3.0	0.64	1.4	0.61
	20.0	5.86	2.648	0.448	60.6	3.22	13.5	2.4	0.65	1.2	0.59
	15.0	4.39	2.485	0.285	50.7	3.40	11.3	1.9	0.67	1.0	0.59
	13.4	3.89	2.430	0.230	47.3	3.49	10.5	1.8	0.67	0.97	0.61
8	21.25	6.23	2.619	0.579	47.6	2.77	11.9	2.2	0.60	1.1	0.59
	18.75	5.49	2.527	0.487	43.7	2.82	10.9	2.0	0.60	1.0	0.57
	16.25	4.76	2.435	0.395	39.8	2.89	9.9	1.8	0.61	0.94	0.56
	13.75	4.02	2.343	0.303	35.8	2.99	9.0	1.5	0.62	0.86	0.56
	11.5	3.36	2.260	0.220	32.3	3.10	8.1	1.3	0.63	0.79	0.58
7	19.75	5.79	2.509	0.629	33.1	2.39	9.4	1.8	0.56	0.96	0.58
	17.25	5.05	2.404	0.524	30.1	2.44	8.6	1.6	0.56	0.86	0.55
	14.75	4.32	2.299	0.419	27.1	2.51	7.7	1.4	0.57	0.79	0.53
	12.25	3.58	2.194	0.314	24.1	2.59	6.9	1.2	0.58	0.71	0.53
	9.8	2.85	2.090	0.210	21.1	2.72	6.0	0.98	0.59	0.63	0.55
6	15.5	4.54	2.279	0.559	19.5	2.07	6.5	1.3	0.53	0.73	0.55
	13.0	3.81	2.157	0.437	17.3	2.13	5.8	1.1	0.53	0.65	0.52
	10.5	3.07	2.034	0.314	15.1	2.22	5.0	0.87	0.53	0.57	0.50
	8.2	2.39	1.920	0.200	13.0	2.34	4.3	0.70	0.54	0.50	0.52
5	11.5	3.36	2.032	0.472	10.4	1.76	4.1	0.82	0.49	0.54	0.51
	9.0	2.63	1.885	0.325	8.8	1.83	3.5	0.64	0.49	0.45	0.48
	6.7	1.95	1.750	0.190	7.4	1.95	3.0	0.48	0.50	0.38	0.49
4	7.25	2.12	1.720	0.320	4.5	1.47	2.3	0.44	0.46	0.35	0.46
	6.25	1.82	1.647	0.247	4.1	1.50	2.1	0.38	0.45	0.32	0.46
	5.4	1.56	1.580	0.180	3.8	1.56	1.9	0.32	0.45	0.29	0.46
3	6.0	1.75	1.596	0.356	2.1	1.08	1.4	0.31	0.42	0.27	0.46
	5.0	1.46	1.498	0.258	1.8	1.12	1.2	0.25	0.41	0.24	0.44
	4.1	1.19	1.410	0.170	1.6	1.17	1.1	0.20	0.41	0.21	0.44

DIMENSIONS, WEIGHTS AND ELEMENTS OF
EQUAL ANGLES



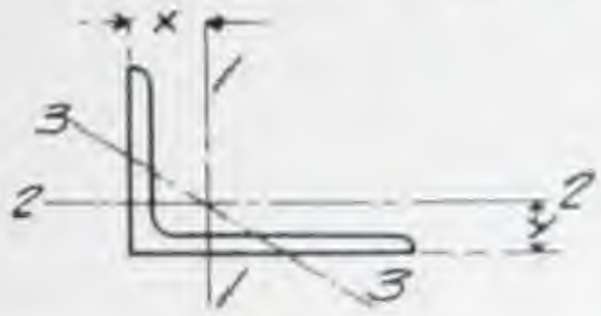
Size	Thickness	Weight per Foot	Area of Section	Axis 1-1 and Axis 2-2				Axis 3-3
				I	r	S	x	$r^{min.}$
In.	In.	Lbs.	In.^{2}	In.^{4}	In.	In.^{3}	In.	In.
8 x 8	1 1/8	56.9	16.73	98.0	2.42	17.5	2.41	1.55
	1 1/16	54.0	15.87	93.5	2.43	16.7	2.39	1.56
	1	51.0	15.00	89.0	2.44	15.8	2.37	1.56
	15/16	48.1	14.12	84.3	2.44	14.9	2.34	1.56
	7/8	45.0	13.23	79.6	2.45	14.0	2.32	1.56
	13/16	42.0	12.34	74.7	2.46	13.1	2.30	1.57
	3/4	38.9	11.44	69.7	2.47	12.2	2.28	1.57
	11/16	35.8	10.53	64.6	2.48	11.2	2.25	1.58
	5/8	32.7	9.61	59.4	2.49	10.3	2.23	1.58
	9/16	29.6	8.68	54.1	2.50	9.3	2.21	1.58
	1/2	26.4	7.75	48.6	2.51	8.4	2.19	1.58
6 x 6	1	37.4	11.00	35.5	1.80	8.6	1.86	1.16
	15/16	35.3	10.37	33.7	1.80	8.1	1.84	1.16
	7/8	33.1	9.73	31.9	1.81	7.6	1.82	1.17
	13/16	31.0	9.09	30.1	1.82	7.2	1.80	1.17
	3/4	28.7	8.44	28.2	1.83	6.7	1.78	1.17
	11/16	26.5	7.78	26.2	1.83	6.2	1.75	1.17
	5/8	24.2	7.11	24.2	1.84	5.7	1.73	1.17
	9/16	21.9	6.43	22.1	1.85	5.1	1.71	1.18
	1/2	19.6	5.75	19.9	1.86	4.6	1.68	1.18
	7/16	17.2	5.06	17.7	1.87	4.1	1.66	1.19
	3/8	14.9	4.36	15.4	1.88	3.5	1.64	1.19
5 x 5	1	30.6	9.00	19.6	1.48	5.8	1.61	0.96
	15/16	28.9	8.50	18.7	1.48	5.5	1.59	0.96
	7/8	27.2	7.98	17.8	1.49	5.2	1.57	0.96
	13/16	25.4	7.47	16.8	1.50	4.9	1.55	0.97
	3/4	23.6	6.94	15.7	1.50	4.5	1.52	0.97
	11/16	21.8	6.40	14.7	1.51	4.2	1.50	0.97
	5/8	20.0	5.86	13.6	1.52	3.9	1.48	0.97
	9/16	18.1	5.31	12.4	1.53	3.5	1.46	0.98
	1/2	16.2	4.75	11.3	1.54	3.2	1.43	0.98
	7/16	14.3	4.18	10.0	1.55	2.8	1.41	0.98
	3/8	12.3	3.61	8.7	1.56	2.4	1.39	0.99
4 x 4	13/16	19.9	5.84	8.1	1.18	3.0	1.29	0.77
	3/4	18.5	5.44	7.7	1.19	2.8	1.27	0.77
	11/16	17.1	5.03	7.2	1.19	2.6	1.25	0.77
	5/8	15.7	4.61	6.7	1.20	2.4	1.23	0.77
	9/16	14.3	4.18	6.1	1.21	2.2	1.21	0.78
	1/2	12.8	3.75	5.6	1.22	2.0	1.18	0.78
	7/16	11.3	3.31	5.0	1.23	1.8	1.16	0.78
	3/8	9.8	2.86	4.4	1.23	1.5	1.14	0.79
	5/16	8.2	2.40	3.7	1.24	1.3	1.12	0.79
	1/4	6.6	1.94	3.0	1.25	1.0	1.09	0.79

DIMENSIONS, WEIGHTS AND ELEMENTS OF EQUAL ANGLES



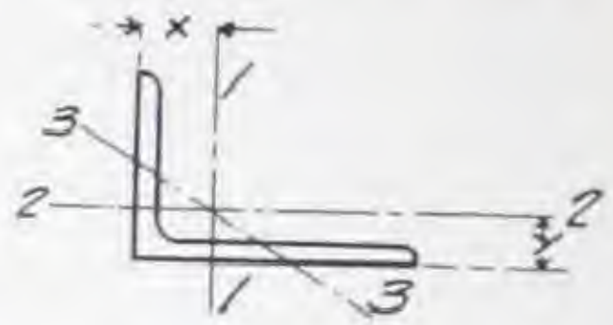
Size	Thickness	Weight per Foot	Area of Section	Axis 1-1 and Axis 2-2				Axis 3-3
				I	r	S	x	$r_{min.}$
In.	In.	Lbs.	In.^{2}	In.^{4}	In.	In.^{3}	In.	In.
3½ x 3½	¾	16.0	4.69	5.0	1.03	2.1	1.15	0.67
	⅜	13.6	3.98	4.3	1.04	1.8	1.10	0.68
	½	11.1	3.25	3.6	1.06	1.5	1.06	0.68
	7/16	9.8	2.87	3.3	1.07	1.3	1.04	0.68
	⅜	8.5	2.48	2.9	1.07	1.2	1.01	0.69
	5/16	7.2	2.09	2.5	1.08	0.98	0.99	0.69
	¼	5.8	1.69	2.0	1.09	0.79	0.97	0.69
3 x 3	⅝	11.5	3.36	2.6	0.88	1.3	0.98	0.57
	½	9.4	2.75	2.2	0.90	1.1	0.93	0.58
	7/16	8.3	2.43	2.0	0.91	0.95	0.91	0.58
	⅜	7.2	2.11	1.8	0.91	0.83	0.89	0.58
	5/16	6.1	1.78	1.5	0.92	0.71	0.87	0.59
	¼	4.9	1.44	1.2	0.93	0.58	0.84	0.59
2½ x 2½	½	7.7	2.25	1.2	0.74	0.73	0.81	0.47
	⅜	5.9	1.73	0.98	0.75	0.57	0.76	0.48
	5/16	5.0	1.47	0.85	0.76	0.48	0.74	0.49
	¼	4.1	1.19	0.70	0.77	0.39	0.72	0.49
	3/16	3.07	0.90	0.55	0.78	0.30	0.69	0.49
	⅛	2.08	0.61	0.38	0.79	0.20	0.67	0.50
2 x 2	⅜	4.7	1.36	0.48	0.59	0.35	0.64	0.39
	5/16	3.92	1.15	0.42	0.60	0.30	0.61	0.39
	¼	3.19	0.94	0.35	0.61	0.25	0.59	0.39
	3/16	2.44	0.71	0.28	0.62	0.19	0.57	0.40
	⅛	1.65	0.48	0.19	0.63	0.13	0.55	0.40
1¾ x 1¾	⅜	3.99	1.17	0.31	0.51	0.26	0.57	0.34
	5/16	3.39	1.00	0.27	0.52	0.23	0.55	0.34
	¼	2.77	0.81	0.23	0.53	0.19	0.53	0.34
	3/16	2.12	0.62	0.18	0.54	0.14	0.51	0.35
	⅛	1.44	0.42	0.13	0.55	0.10	0.48	0.35
1½ x 1½	⅜	3.35	0.98	0.19	0.44	0.19	0.51	0.29
	5/16	2.86	0.84	0.16	0.44	0.16	0.49	0.29
	¼	2.34	0.69	0.14	0.45	0.13	0.47	0.29
	3/16	1.80	0.53	0.11	0.46	0.10	0.44	0.29
	⅛	1.23	0.36	0.08	0.46	0.07	0.42	0.30
1¼ x 1¼	¼	1.92	0.56	0.08	0.37	0.09	0.40	0.24
	3/16	1.48	0.43	0.06	0.38	0.07	0.38	0.24
	⅛	1.01	0.30	0.04	0.38	0.05	0.35	0.25
1 x 1	¼	1.49	0.44	0.04	0.29	0.06	0.34	0.19
	3/16	1.16	0.34	0.03	0.30	0.04	0.32	0.19
	⅛	0.80	0.23	0.02	0.31	0.03	0.30	0.19

DIMENSIONS, WEIGHTS AND ELEMENTS OF
UNEQUAL ANGLES



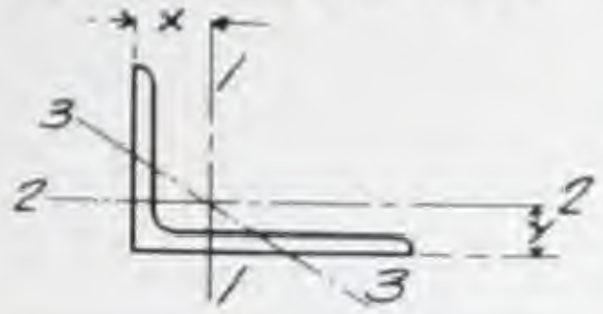
Size	Thickness	Wt per Foot	Area of Section	Axis 1-1				Axis 2-2				Axis 3-3
				I	r	S	x	I	r	S	y	r_{min}
In.	In.	Lbs.	In.^{2}	In.^{4}	In.	In.^{3}	In.	In.^{4}	In.	In.^{3}	In.	In.
8 x 6	1	44.2	13.00	80.8	2.49	15.1	2.65	38.8	1.73	8.9	1.65	1.28
	15/16	41.7	12.25	76.6	2.50	14.3	2.63	36.8	1.73	8.4	1.63	1.28
	7/8	39.1	11.48	72.3	2.51	13.4	2.61	34.9	1.74	7.9	1.61	1.28
	13/16	36.5	10.72	67.9	2.52	12.5	2.59	32.8	1.75	7.4	1.59	1.29
	3/4	33.8	9.94	63.4	2.53	11.7	2.56	30.7	1.76	6.9	1.56	1.29
	11/16	31.2	9.15	58.8	2.54	10.8	2.54	28.6	1.77	6.4	1.54	1.29
	5/8	28.5	8.36	54.1	2.54	9.9	2.52	26.3	1.77	5.9	1.52	1.30
	9/16	25.7	7.56	49.3	2.55	8.9	2.50	24.0	1.78	5.3	1.50	1.30
	1/2	23.0	6.75	44.3	2.56	8.0	2.47	21.7	1.79	4.8	1.47	1.30
	7/16	20.2	5.93	39.2	2.57	7.1	2.45	19.3	1.80	4.2	1.45	1.30
8 x 3½	1	35.7	10.50	66.2	2.51	13.7	3.17	7.8	0.86	3.0	0.92	0.73
	15/16	33.7	9.90	62.9	2.52	12.9	3.14	7.4	0.87	2.9	0.89	0.73
	7/8	31.7	9.30	59.4	2.53	12.2	3.12	7.1	0.87	2.7	0.87	0.73
	13/16	29.6	8.68	55.9	2.54	11.4	3.10	6.7	0.88	2.5	0.85	0.73
	3/4	27.5	8.06	52.3	2.55	10.6	3.07	6.3	0.88	2.3	0.82	0.73
	11/16	25.3	7.43	48.5	2.56	9.8	3.05	5.9	0.89	2.2	0.80	0.73
	5/8	23.2	6.80	44.7	2.57	9.0	3.03	5.4	0.90	2.0	0.78	0.74
	9/16	21.0	6.15	40.8	2.57	8.2	3.00	5.0	0.90	1.8	0.75	0.74
	1/2	18.7	5.50	36.7	2.58	7.3	2.98	4.5	0.91	1.6	0.73	0.74
	7/16	16.5	4.84	32.5	2.59	6.4	2.95	4.1	0.92	1.5	0.70	0.74
7 x 3½	1	32.3	9.50	45.4	2.19	10.6	2.71	7.5	0.89	3.0	0.96	0.74
	15/16	30.5	8.97	43.1	2.19	10.0	2.69	7.2	0.89	2.8	0.94	0.74
	7/8	28.7	8.42	40.8	2.20	9.4	2.66	6.8	0.90	2.6	0.91	0.74
	13/16	26.8	7.87	38.4	2.21	8.8	2.64	6.5	0.91	2.5	0.89	0.74
	3/4	24.9	7.31	36.0	2.22	8.2	2.62	6.1	0.91	2.3	0.87	0.74
	11/16	23.0	6.75	33.5	2.23	7.6	2.60	5.7	0.92	2.1	0.85	0.74
	5/8	21.0	6.17	30.9	2.24	7.0	2.57	5.3	0.93	2.0	0.82	0.75
	9/16	19.1	5.59	28.2	2.25	6.3	2.55	4.9	0.93	1.8	0.80	0.75
	1/2	17.0	5.00	25.4	2.25	5.7	2.53	4.4	0.94	1.6	0.78	0.75
	7/16	15.0	4.40	22.6	2.26	5.0	2.50	4.0	0.95	1.4	0.75	0.76
	3/8	13.0	3.80	19.6	2.27	4.3	2.48	3.5	0.96	1.3	0.73	0.76
6 x 4	1	30.6	9.00	30.8	1.85	8.0	2.17	10.8	1.09	3.8	1.17	0.85
	15/16	28.9	8.50	29.3	1.86	7.6	2.14	10.3	1.10	3.6	1.14	0.85
	7/8	27.2	7.98	27.7	1.86	7.2	2.12	9.8	1.11	3.4	1.12	0.86
	13/16	25.4	7.47	26.1	1.87	6.7	2.10	9.2	1.11	3.2	1.10	0.86
	3/4	23.6	6.94	24.5	1.88	6.2	2.08	8.7	1.12	3.0	1.08	0.86
	11/16	21.8	6.40	22.8	1.89	5.8	2.06	8.1	1.13	2.8	1.06	0.86
	5/8	20.0	5.86	21.1	1.90	5.3	2.03	7.5	1.13	2.5	1.03	0.86
	9/16	18.1	5.31	19.3	1.90	4.8	2.01	6.9	1.14	2.3	1.01	0.87
	1/2	16.2	4.75	17.4	1.91	4.3	1.99	6.3	1.15	2.1	0.99	0.87
	7/16	14.3	4.18	15.5	1.92	3.8	1.96	5.6	1.16	1.8	0.96	0.87
	3/8	12.3	3.61	13.5	1.93	3.3	1.94	4.9	1.17	1.6	0.94	0.88

DIMENSIONS, WEIGHTS AND ELEMENTS OF
UNEQUAL ANGLES



Size	Thickness	Wt. per Foot	Area of Section	Axis 1-1				Axis 2-2				Axis 3-3
				I	r	S	x	I	r	S	y	$r_{min.}$
In.	In.	Lbs.	In.²	In.⁴	In.	In.³	In.	In.⁴	In.	In.³	In.	In.
6 x 3½	1	28.9	8.50	29.2	1.85	7.8	2.26	7.2	0.92	2.9	1.01	0.74
	15/16	27.3	8.03	27.8	1.86	7.4	2.24	6.9	0.93	2.7	0.99	0.74
	7/8	25.7	7.55	26.4	1.87	7.0	2.22	6.6	0.93	2.6	0.97	0.75
	13/16	24.0	7.06	24.9	1.88	6.6	2.20	6.2	0.94	2.4	0.95	0.75
	3/4	22.4	6.56	23.3	1.89	6.1	2.18	5.8	0.94	2.3	0.93	0.75
	11/16	20.6	6.06	21.7	1.89	5.6	2.15	5.5	0.95	2.1	0.90	0.75
	5/8	18.9	5.55	20.1	1.90	5.2	2.13	5.1	0.96	1.9	0.88	0.75
	9/16	17.1	5.03	18.4	1.91	4.7	2.11	4.7	0.96	1.8	0.86	0.75
	1/2	15.3	4.50	16.6	1.92	4.2	2.08	4.3	0.97	1.6	0.83	0.76
	7/16	13.5	3.97	14.8	1.93	3.7	2.06	3.8	0.98	1.4	0.81	0.76
	3/8	11.7	3.42	12.9	1.94	3.3	2.04	3.3	0.99	1.2	0.79	0.77
	5/16	9.8	2.87	10.9	1.95	2.7	2.01	2.9	1.00	1.0	0.76	0.77
5 x 4	7/8	24.2	7.11	16.4	1.52	5.0	1.71	9.2	1.14	3.3	1.21	0.84
	13/16	22.7	6.65	15.5	1.53	4.7	1.68	8.7	1.15	3.1	1.18	0.84
	3/4	21.1	6.19	14.6	1.54	4.4	1.66	8.2	1.15	2.9	1.16	0.84
	11/16	19.5	5.72	13.6	1.54	4.1	1.64	7.7	1.16	2.7	1.14	0.84
	5/8	17.8	5.23	12.6	1.55	3.7	1.62	7.1	1.17	2.5	1.12	0.84
	9/16	16.2	4.75	11.6	1.56	3.4	1.60	6.6	1.18	2.3	1.10	0.85
	1/2	14.5	4.25	10.5	1.57	3.1	1.57	6.0	1.18	2.0	1.07	0.85
	7/16	12.8	3.75	9.3	1.58	2.7	1.55	5.3	1.19	1.8	1.05	0.85
	3/8	11.0	3.23	8.1	1.59	2.3	1.53	4.7	1.20	1.6	1.03	0.86
5 x 3½	7/8	22.7	6.67	15.7	1.53	4.9	1.79	6.2	0.96	2.5	1.04	0.75
	13/16	21.3	6.25	14.8	1.54	4.6	1.77	5.9	0.97	2.4	1.02	0.75
	3/4	19.8	5.81	13.9	1.55	4.3	1.75	5.6	0.98	2.2	1.00	0.75
	11/16	18.3	5.37	13.0	1.56	4.0	1.72	5.2	0.98	2.1	0.97	0.75
	5/8	16.8	4.92	12.0	1.56	3.7	1.70	4.8	0.99	1.9	0.95	0.75
	9/16	15.2	4.47	11.0	1.57	3.3	1.68	4.4	1.00	1.7	0.93	0.75
	1/2	13.6	4.00	10.0	1.58	3.0	1.66	4.0	1.01	1.6	0.91	0.75
	7/16	12.0	3.53	8.9	1.59	2.6	1.63	3.6	1.01	1.4	0.88	0.76
	3/8	10.4	3.05	7.8	1.60	2.3	1.61	3.2	1.02	1.2	0.86	0.76
	5/16	8.7	2.56	6.6	1.61	1.9	1.59	2.7	1.03	1.0	0.84	0.76
5 x 3	13/16	19.9	5.84	14.0	1.55	4.5	1.86	3.7	0.80	1.7	0.86	0.64
	3/4	18.5	5.44	13.2	1.55	4.2	1.84	3.5	0.80	1.6	0.84	0.64
	11/16	17.1	5.03	12.3	1.56	3.9	1.82	3.3	0.81	1.5	0.82	0.64
	5/8	15.7	4.61	11.4	1.57	3.5	1.80	3.1	0.81	1.4	0.80	0.64
	9/16	14.3	4.18	10.4	1.58	3.2	1.77	2.8	0.82	1.3	0.77	0.65
	1/2	12.8	3.75	9.5	1.59	2.9	1.75	2.6	0.83	1.1	0.75	0.65
	7/16	11.3	3.31	8.4	1.60	2.6	1.73	2.3	0.84	1.0	0.73	0.65
	3/8	9.8	2.86	7.4	1.61	2.2	1.70	2.0	0.84	0.89	0.70	0.65
	5/16	8.2	2.40	6.3	1.61	1.9	1.68	1.8	0.85	0.75	0.68	0.66

DIMENSIONS, WEIGHTS AND ELEMENTS OF
UNEQUAL ANGLES



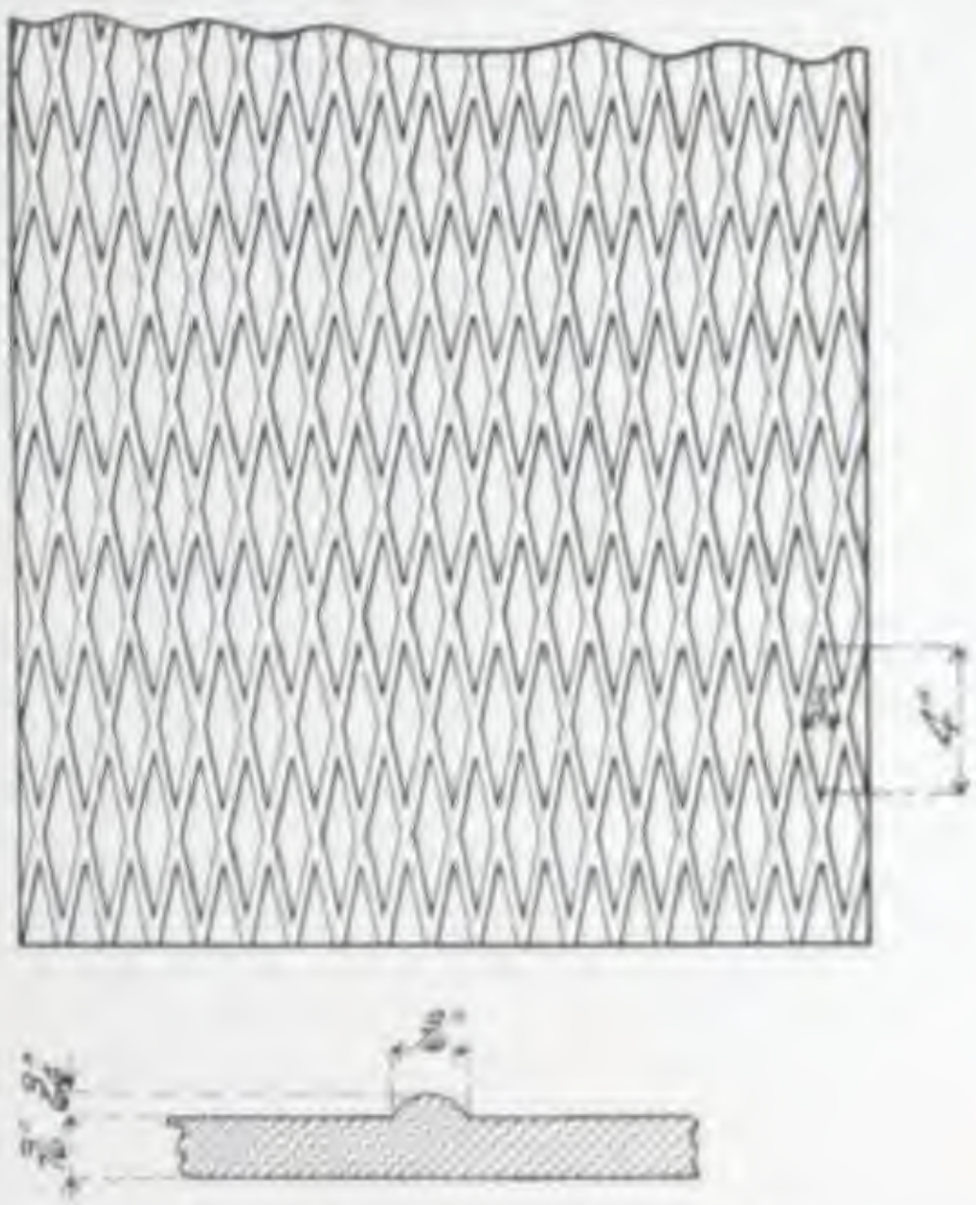
Size	Thickness	Wt. per Foot	Area of Section	Axis 1-1				Axis 2-2				Axis 3-3
				I	r	S	x	I	r	S	y	$r_{min.}$
In.	In.	Lbs.	In.^{2}	In.^{4}	In.	In.^{3}	In.	In.^{4}	In.	In.^{3}	In.	In.
4½ x 3	¾	17.3	5.06	9.7	1.39	3.4	1.63	3.4	0.82	1.6	0.88	0.64
	11/16	16.0	4.68	9.1	1.39	3.1	1.60	3.2	0.83	1.5	0.85	0.64
	⅝	14.7	4.30	8.4	1.40	2.9	1.58	3.0	0.83	1.4	0.83	0.64
	9/16	13.3	3.90	7.8	1.41	2.6	1.56	2.8	0.85	1.3	0.81	0.64
	½	11.9	3.50	7.0	1.42	2.4	1.54	2.5	0.95	1.1	0.79	0.65
	7/16	10.6	3.09	6.3	1.43	2.1	1.51	2.3	0.85	1.0	0.76	0.65
	⅜	9.1	2.67	5.5	1.44	1.8	1.49	2.0	0.86	0.88	0.74	0.66
	5/16	7.7	2.25	4.7	1.44	1.5	1.47	1.7	0.87	0.75	0.72	0.66
4 x 3½	¾	17.3	5.06	7.3	1.20	2.8	1.34	5.2	1.01	2.1	1.09	0.72
	11/16	16.0	4.68	6.9	1.21	2.6	1.32	4.9	1.02	2.0	1.07	0.72
	⅝	14.7	4.30	6.4	1.22	2.4	1.29	4.5	1.03	1.8	1.04	0.72
	9/16	13.3	3.90	5.9	1.23	2.1	1.27	4.2	1.03	1.7	1.02	0.72
	½	11.9	3.50	5.3	1.23	1.9	1.25	3.8	1.04	1.5	1.00	0.72
	7/16	10.6	3.09	4.8	1.24	1.7	1.23	3.4	1.05	1.3	0.98	0.72
	⅜	9.1	2.67	4.2	1.25	1.5	1.21	3.0	1.06	1.2	0.96	0.73
	5/16	7.7	2.25	3.6	1.26	1.3	1.18	2.6	1.07	1.0	0.93	0.73
4 x 3	¾	16.0	4.69	6.9	1.22	2.7	1.42	3.3	0.84	1.6	0.92	0.64
	11/16	14.8	4.34	6.5	1.22	2.5	1.39	3.1	0.84	1.5	0.89	0.64
	⅝	13.6	3.98	6.0	1.23	2.3	1.37	2.9	0.85	1.4	0.87	0.64
	9/16	12.4	3.62	5.6	1.24	2.1	1.35	2.7	0.86	1.2	0.85	0.64
	½	11.1	3.25	5.0	1.25	1.9	1.33	2.4	0.86	1.1	0.83	0.64
	7/16	9.8	2.87	4.5	1.25	1.7	1.30	2.2	0.87	1.0	0.80	0.64
	⅜	8.5	2.48	4.0	1.26	1.5	1.28	1.9	0.88	0.87	0.78	0.64
	5/16	7.2	2.09	3.4	1.27	1.2	1.26	1.7	0.89	0.74	0.76	0.65
	¼	5.8	1.69	2.8	1.28	1.0	1.24	1.4	0.89	0.60	0.74	0.65
3½ x 3	¾	14.7	4.31	4.7	1.04	2.1	1.21	3.1	0.85	1.5	0.96	0.62
	11/16	13.6	4.00	4.4	1.05	1.9	1.19	3.0	0.86	1.4	0.94	0.62
	⅝	12.5	3.67	4.1	1.06	1.8	1.17	2.8	0.87	1.3	0.92	0.62
	9/16	11.4	3.34	3.8	1.07	1.6	1.15	2.5	0.87	1.2	0.90	0.62
	½	10.2	3.00	3.5	1.07	1.5	1.13	2.3	0.88	1.1	0.88	0.62
	7/16	9.1	2.65	3.1	1.08	1.3	1.10	2.1	0.89	0.98	0.85	0.62
	⅜	7.9	2.30	2.7	1.09	1.1	1.08	1.8	0.90	0.85	0.83	0.62
	5/16	6.6	1.93	2.3	1.10	0.96	1.06	1.6	0.90	0.72	0.81	0.63
	¼	5.4	1.56	1.9	1.11	0.78	1.04	1.3	0.91	0.58	0.79	0.63
3½x2½	⅝	11.5	3.36	3.8	1.07	1.7	1.25	1.6	0.69	0.92	0.75	0.53
	9/16	10.4	3.06	3.6	1.08	1.6	1.23	1.5	0.70	0.84	0.73	0.53
	½	9.4	2.75	3.2	1.09	1.4	1.20	1.4	0.70	0.76	0.70	0.53
	7/16	8.3	2.43	2.9	1.09	1.3	1.18	1.2	0.71	0.68	0.68	0.54
	⅜	7.2	2.11	2.6	1.10	1.1	1.16	1.1	0.72	0.59	0.66	0.54
	5/16	6.1	1.78	2.2	1.11	0.93	1.14	0.94	0.73	0.50	0.64	0.54
	¼	4.9	1.44	1.8	1.12	0.75	1.11	0.78	0.74	0.41	0.61	0.54

DIMENSIONS, WEIGHTS AND ELEMENTS OF
UNEQUAL ANGLES

Size	Thickness	Wt. per Foot	Area of Section	Axis 1-1				Axis 2-2				Axis 3-3
				I	r	S	x	I	r	S	y	$r_{min.}$
In.	In.	Lbs.	In.	In.⁴	In.	In.³	In.	In.⁴	In.	In.³	In.	In.
3 x 2½	½	8.5	2.50	2.1	0.91	1.0	1.00	1.3	0.72	0.74	0.75	0.52
	7/16	7.6	2.21	1.9	0.92	0.93	0.98	1.2	0.73	0.66	0.73	0.52
	3/8	6.6	1.92	1.7	0.93	0.81	0.96	1.0	0.74	0.58	0.71	0.52
	5/16	5.6	1.62	1.4	0.94	0.69	0.93	0.90	0.74	0.49	0.68	0.53
	¼	4.5	1.31	1.2	0.95	0.56	0.91	0.74	0.75	0.40	0.66	0.53
3 x 2	½	7.7	2.25	1.9	0.92	1.0	1.08	0.67	0.55	0.47	0.58	0.43
	7/16	6.8	2.00	1.7	0.93	0.89	1.06	0.61	0.55	0.42	0.56	0.43
	3/8	5.9	1.73	1.5	0.94	0.78	1.04	0.54	0.56	0.37	0.54	0.43
	5/16	5.0	1.47	1.3	0.95	0.66	1.02	0.47	0.57	0.32	0.52	0.43
	¼	4.1	1.19	1.1	0.95	0.54	0.99	0.39	0.57	0.25	0.49	0.43
2½ x 2	½	6.8	2.00	1.1	0.75	0.70	0.88	0.64	0.56	0.46	0.63	0.42
	7/16	6.1	1.78	1.0	0.76	0.62	0.85	0.58	0.57	0.41	0.60	0.42
	3/8	5.3	1.55	0.91	0.77	0.55	0.83	0.51	0.58	0.36	0.58	0.42
	5/16	4.5	1.31	0.79	0.78	0.47	0.81	0.45	0.58	0.31	0.56	0.42
	¼	3.62	1.06	0.65	0.78	0.38	0.79	0.37	0.59	0.25	0.54	0.42
	3/16	2.75	0.81	0.51	0.79	0.29	0.76	0.29	0.60	0.20	0.51	0.43
	⅛	1.86	0.55	0.35	0.80	0.20	0.74	0.20	0.61	0.13	0.49	0.43
2½x1½	5/16	3.92	1.15	0.71	0.79	0.44	0.90	0.19	0.41	0.17	0.40	0.32
	¼	3.19	0.94	0.59	0.79	0.36	0.88	0.16	0.41	0.14	0.38	0.32
	3/16	2.44	0.72	0.46	0.80	0.28	0.85	0.13	0.42	0.11	0.35	0.33
2¼x1½	7/16	5.0	1.45	0.68	0.69	0.48	0.83	0.24	0.41	0.23	0.46	0.32
	3/8	4.4	1.27	0.61	0.69	0.42	0.81	0.21	0.41	0.20	0.44	0.32
	5/16	3.66	1.07	0.53	0.70	0.36	0.79	0.19	0.42	0.17	0.42	0.32
	¼	2.98	0.88	0.44	0.71	0.30	0.77	0.16	0.42	0.14	0.39	0.32
	3/16	2.28	0.67	0.34	0.72	0.23	0.75	0.12	0.43	0.11	0.37	0.33
2 x 1½	3/8	3.99	1.17	0.43	0.61	0.34	0.71	0.21	0.42	0.20	0.46	0.32
	5/16	3.39	1.00	0.38	0.62	0.29	0.69	0.18	0.42	0.17	0.44	0.32
	¼	2.77	0.81	0.32	0.62	0.24	0.66	0.15	0.43	0.14	0.41	0.32
	3/16	2.12	0.62	0.25	0.63	0.18	0.64	0.12	0.44	0.11	0.39	0.32
	⅛	1.44	0.42	0.17	0.64	0.13	0.62	0.09	0.45	0.08	0.37	0.33
2 x 1¼	¼	2.55	0.75	0.30	0.63	0.23	0.71	0.09	0.34	0.10	0.33	0.27
	3/16	1.96	0.57	0.23	0.64	0.18	0.69	0.07	0.35	0.08	0.31	0.27
1¾x1¼	¼	2.34	0.69	0.20	0.54	0.18	0.60	0.09	0.35	0.10	0.35	0.27
	3/16	1.80	0.53	0.16	0.55	0.14	0.58	0.07	0.36	0.08	0.33	0.27
	⅛	1.23	0.36	0.11	0.56	0.09	0.56	0.05	0.37	0.05	0.31	0.27
1½x1¼	3/16	2.59	0.76	0.16	0.45	0.16	0.52	0.10	0.35	0.11	0.40	0.26
	¼	2.13	0.63	0.13	0.46	0.13	0.50	0.08	0.36	0.09	0.38	0.26
	3/16	1.64	0.48	0.10	0.46	0.10	0.48	0.07	0.37	0.07	0.35	0.26

CHECKERED PLATES

These plates are for use in boiler and engine rooms, breweries, for stairways, fire escapes, gutter plates, car platforms, sidewalks, deck plates on ships and every place where a cast iron plate is now used. They are made of the best open hearth steel, and are much stronger than cast iron floor plates, cheaper, and fifty per cent lighter.



No. 6.—Checkered Plate, showing Section at Rib

Widths and Maximum Lengths Rolled

Thickness, Inches	Width and Length, Inches			Weight per Square Foot, Pounds
	8 to 31½	42 to 48	48½ to 60	
½	120	240	240	21 4
7/16	120	240	240	18 9
3/8	120	240	240	16 3
5/16	120	240	240	13 8
¼	120	240	240	11 2
3/16	120	180		8 7

The sizes carried in stock are ⅜-inch, ¼-inch and 5/16-inch. Others are special.

RECTANGULAR UNIVERSAL PLATES—Carbon Steel

UNIVERSAL MILL PLATES, ONE-FOURTH INCH AND OVER, EXTREME SIZES

Thickness, Inches	Weight Lbs. per Sq. Ft.	Widths and Lengths in Inches										
		48-46	45-41	40-36	35-31	30-26	25-20	19-17	16-15	14-12	11	10-6⅜
¼	10.20						1020	1020	1020	1020	540	540
5/16	12.75	1020	1020	1140	1260	1320	1320	1080	1080	1080	600	600
3/8	15.30	1200	1200	1320	1380	1380	1380	1080	1080	1080	900	840
7/16	17.85	1320	1320	1380	1380	1380	1380	1080	1080	1080	900	840
½	20.40	1380	1380	1380	1380	1380	1380	1080	1080	1080	1020	840
9/16	22.95	1380	1380	1380	1380	1380	1380	1080	1080	1080	1020	840
5/8	25.50	1380	1380	1380	1380	1380	1380	1080	1080	1080	1020	840
¾	30.60	1353	1357	1363	1372	1380	1380	1080	1080	1080	900	840
7/8	35.70	1160	1163	1169	1177	1188	1203	1080	1080	1080	900	840
1	40.80	1015	1018	1023	1030	1039	1052	1080	1080	1080	900	840
1⅛	45.90	903	905	910	916	924	936	1080	1080	1080	840	840
1¼	51.00	812	814	818	824	832	842	1071	1080	1080	840	840
1⅜	56.10	738	740	744	749	756	766	973	1080	1080	840	840
1½	61.20	677	679	682	687	693	702	892	1059	1080	840	840
1⅝	66.30	625	626	629	634	640	648	823	978	1080	840	840
1¾	71.40	580	581	584	588	594	601	765	908	1038	720	720
1⅞	76.50	541	543	545	549	554	561	714	847	968	660	720
2	81.60	507	509	511	515	519	526	669	794	907	600	720

RECTANGULAR AND CIRCULAR PLATES—Carbon Steel

SHEARED PLATES, THREE-SIXTEENTH INCH, EXTREME SIZES

Thickness, Inches	Weight, Lbs. per Sq. Ft.	Widths and Lengths in Inches										Diam., In.
		90	84	78	72	70	68	66	64	60	54-24	
3/16	7.65	270	320	345	375	390	400	420	450	470	480	90

RECTANGULAR AND CIRCULAR PLATES—Carbon Steel

SHEARED PLATES, ONE-FOURTH INCH AND OVER, EXTREME SIZES

Thickness, Inches	Weight Lbs. per Sq. Ft.	Widths and Lengths in Inches										Diam. In.
		128	120	120	114	108	102	96	90	84	78	
¼	10 20				175	230	280	300	350	375	400	115
⅜	12 75			240	270	320	360	380	420	440	460	120
½	15 30	220	240	270	320	365	380	410	450	500	520	130
⅝	17 85	240	270	300	360	370	410	430	460	510	520	130
¾	20 40	260	270	320	365	400	450	480	510	520	580	130
⅞	22 95	260	270	320	373	420	470	500	530	570	600	130
1	25 50	260	300	350	390	450	500	520	540	600	620	130
1⅛	28 65	260	300	360	420	450	500	520	540	600	620	130
1¼	30 60	260	300	360	400	450	460	520	540	600	620	130
1⅜	33 15	260	300	340	385	440	480	510	520	600	620	130
1½	35 70	260	300	320	375	440	460	510	520	600	620	130
1	40 80	250	300	300	340	440	490	500	520	560	600	130
1⅛	45 90	250	300	300	330	410	440	450	500	520	580	130
1¼	51 00	240	270	300	310	380	400	420	460	500	560	130
1⅜	61 20	220	250	260	280	330	320	340	420	440	480	130
1½	71 40	200	200	220	240	280	270	300	360	380	410	130
2	81 60	180	180	190	210	240	240	260	320	360	360	130
2¼	91 80	150	160	170	190	210	210	250	280	295	320	130

Thickness, Inches	Weight Lbs. per Sq. Ft.	Widths and Lengths in Inches										Diam. In.
		72	66	60	54	50	48	42	36	30	24	
¼	10 20	430	475	525	580	580	520	580	580	580	580	115
⅜	12 75	480	560	560	520	575	575	580	580	560	580	120
½	15 30	600	600	620	620	620	620	600	580	600	600	120
⅝	17 85	600	620	620	640	640	640	600	580	600	600	130
¾	20 40	610	620	620	640	640	640	600	580	620	600	130
⅞	22 95	620	640	640	640	640	640	600	580	600	600	130
1	25 50	620	640	640	640	640	640	600	580	600	600	130
1⅛	28 65	620	640	640	640	640	640	600	580	600	580	130
1¼	30 60	620	640	640	640	640	640	600	580	600	580	130
1⅜	33 15	620	640	640	640	640	640	600	580	570	650	130
1½	35 70	620	640	640	640	640	640	600	560	560	570	130
1	40 80	600	640	640	640	640	640	580	560	520	580	130
1⅛	45 90	580	620	620	640	640	640	580	560	520	300	130
1¼	51 00	520	600	600	600	600	600	560	560	520	420	130
1⅜	61 20	520	600	600	600	600	600	540	540	420	320	130
1½	71 40	450	500	520	520	520	520	500	500	420	300	130
2	81 60	400	440	480	500	500	500	500	500	400	320	130
2¼	91 80	350	360	420	450	450	420	420	420	300	300	130

WEIGHTS OF FLAT ROLLED STEEL
POUNDS PER LINEAL FOOT

Width, Inches	Thickness, Inches															
	1/8	5/32	3/16	7/32	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
1/4	.053	.106	.159	.213	.27	.32	.37	.43	.48	.53	.58	.64	.69	.74	.80	.85	
1/2	.106	.213	.319	.425	.53	.64	.74	.85	.96	1.06	1.17	1.28	1.38	1.49	1.59	1.70	
3/4	.159	.319	.478	.638	.80	.96	1.12	1.28	1.43	1.59	1.76	1.91	2.07	2.23	2.39	2.55	
1	.213	.425	.638	.850	1.06	1.28	1.49	1.70	1.91	2.13	2.34	2.55	2.76	2.98	3.19	3.40	
1 1/4	.266	.531	.797	1.063	1.33	1.59	1.86	2.13	2.39	2.66	2.92	3.19	3.45	3.72	3.98	4.25	
1 1/2	.319	.638	.956	1.275	1.59	1.91	2.23	2.56	2.87	3.19	3.51	3.83	4.14	4.46	4.78	5.10	
1 3/4	.372	.744	1.116	1.488	1.86	2.23	2.60	2.98	3.35	3.72	4.09	4.46	4.83	5.21	5.58	5.95	
2	.425	.850	1.275	1.700	2.13	2.55	2.98	3.40	3.83	4.25	4.68	5.10	5.53	5.95	6.38	6.80	
2 1/4	.478	.956	1.434	1.913	2.39	2.87	3.35	3.83	4.30	4.78	5.26	5.74	6.22	6.69	7.17	7.65	
2 1/2	.531	1.063	1.594	2.125	2.66	3.19	3.72	4.25	4.78	5.31	5.84	6.38	6.91	7.44	7.97	8.50	
2 3/4	.584	1.169	1.753	2.338	2.92	3.51	4.09	4.68	5.26	5.84	6.43	7.01	7.60	8.18	8.77	9.35	
3	.638	1.275	1.913	2.550	3.19	3.83	4.46	5.10	5.74	6.38	7.01	7.65	8.29	8.93	9.56	10.20	
3 1/4	.691	1.381	2.072	2.763	3.45	4.14	4.83	5.53	6.22	6.91	7.60	8.29	8.98	9.67	10.36	11.05	
3 1/2	.744	1.488	2.231	2.975	3.72	4.46	5.21	5.95	6.69	7.44	8.18	8.93	9.67	10.41	11.16	11.90	
3 3/4	.797	1.594	2.391	3.188	3.98	4.78	5.58	6.38	7.17	7.97	8.77	9.56	10.36	11.16	11.95	12.75	
4	.850	1.700	2.550	3.400	4.25	5.10	5.95	6.80	7.65	8.50	9.35	10.20	11.05	11.90	12.75	13.60	
4 1/4	.903	1.806	2.709	3.613	4.52	5.42	6.32	7.23	8.13	9.03	9.93	10.84	11.74	12.64	13.55	14.45	
4 1/2	.956	1.913	2.869	3.825	4.78	5.74	6.69	7.65	8.61	9.56	10.52	11.48	12.43	13.39	14.34	15.30	
4 3/4	1.009	2.019	3.028	4.038	5.05	6.06	7.07	8.08	9.08	10.09	11.10	12.11	13.12	14.13	15.14	16.15	
5	1.063	2.125	3.188	4.250	5.31	6.38	7.44	8.50	9.56	10.63	11.69	12.75	13.81	14.88	15.94	17.00	
5 1/4	1.116	2.231	3.347	4.463	5.58	6.69	7.81	8.93	10.04	11.16	12.27	13.39	14.50	15.62	16.73	17.85	
5 1/2	1.169	2.338	3.506	4.675	5.84	7.01	8.18	9.35	10.52	11.69	12.86	14.03	15.19	16.36	17.53	18.70	
5 3/4	1.222	2.444	3.666	4.888	6.11	7.33	8.55	9.78	11.00	12.22	13.44	14.66	15.88	17.11	18.33	19.55	
6	1.275	2.550	3.825	5.100	6.38	7.65	8.93	10.20	11.48	12.75	14.03	15.30	16.58	17.85	19.13	20.40	
6 1/4	1.328	2.656	3.984	5.313	6.64	7.97	9.30	10.63	11.95	13.28	14.61	15.94	17.27	18.59	19.92	21.25	
6 1/2	1.381	2.763	4.144	5.525	6.91	8.29	9.67	11.05	12.43	13.81	15.19	16.58	17.96	19.34	20.72	22.10	
6 3/4	1.434	2.869	4.303	5.738	7.17	8.61	10.04	11.48	12.91	14.34	15.78	17.21	18.65	20.08	21.52	22.95	
7	1.488	2.975	4.463	5.950	7.44	8.93	10.41	11.90	13.39	14.88	16.36	17.85	19.34	20.83	22.31	23.80	
7 1/4	1.541	3.081	4.622	6.163	7.70	9.24	10.78	12.33	13.87	15.41	16.95	18.49	20.03	21.57	23.11	24.65	
7 1/2	1.594	3.188	4.781	6.375	7.97	9.56	11.16	12.75	14.34	15.94	17.53	19.13	20.72	22.31	23.91	25.50	
7 3/4	1.647	3.294	4.941	6.588	8.23	9.88	11.53	13.18	14.82	16.47	18.12	19.76	21.41	23.06	24.70	26.35	
8	1.700	3.400	5.100	6.800	8.50	10.20	11.90	13.60	15.30	17.00	18.70	20.40	22.10	23.80	25.50	27.20	
8 1/4	1.753	3.506	5.259	7.013	8.77	10.52	12.27	14.03	15.78	17.53	19.28	21.04	22.79	24.54	26.30	28.05	
8 1/2	1.806	3.613	5.419	7.225	9.03	10.84	12.64	14.45	16.26	18.06	19.87	21.68	23.48	25.29	27.10	28.90	
8 3/4	1.859	3.719	5.578	7.438	9.30	11.16	13.02	14.88	16.73	18.59	20.45	22.31	24.17	26.03	27.89	29.75	
9	1.913	3.825	5.738	7.650	9.56	11.48	13.39	15.30	17.21	19.13	21.04	22.95	24.86	26.78	28.69	30.60	
9 1/4	1.966	3.931	5.897	7.863	9.83	11.79	13.76	15.73	17.69	19.66	21.62	23.59	25.55	27.52	29.48	31.45	
9 1/2	2.019	4.038	6.056	8.075	10.09	12.11	14.13	16.15	18.17	20.19	22.21	24.23	26.24	28.26	30.28	32.30	
9 3/4	2.072	4.144	6.216	8.288	10.36	12.43	14.50	16.58	18.65	20.72	22.79	24.86	26.93	29.01	31.08	33.15	
10	2.125	4.250	6.375	8.500	10.63	12.75	14.88	17.00	19.13	21.25	23.38	25.50	27.63	29.75	31.88	34.00	
10 1/4	2.178	4.356	6.534	8.713	10.89	13.07	15.25	17.43	19.60	21.78	23.96	26.14	28.32	30.49	32.67	34.85	
10 1/2	2.231	4.463	6.694	8.925	11.16	13.39	15.62	17.85	20.08	22.31	24.54	26.78	29.01	31.24	33.47	35.70	
10 3/4	2.284	4.569	6.853	9.138	11.42	13.71	15.99	18.28	20.57	22.84	25.13	27.41	29.70	31.98	34.27	36.55	
11	2.338	4.675	7.013	9.350	11.69	14.03	16.36	18.70	21.04	23.38	25.71	28.05	30.39	32.73	35.06	37.40	
11 1/4	2.391	4.781	7.172	9.563	11.95	14.34	16.73	19.13	21.52	23.91	26.30	28.69	31.08	33.47	35.86	38.25	
11 1/2	2.444	4.888	7.331	9.775	12.22	14.66	17.11	19.55	21.99	24.44	26.88	29.33	31.77	34.21	36.66	39.10	
11 3/4	2.497	4.994	7.491	9.988	12.48	14.98	17.48	19.98	22.47	24.97	27.47	29.96	32.46	34.96	37.45	39.95	
12	2.550	5.100	7.650	10.200	12.75	15.30	17.85	20.40	22.95	25.50	28.05	30.60	33.15	35.70	38.25	40.80	

WEIGHTS OF FLAT ROLLED STEEL
POUNDS PER LINEAL FOOT

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
12½	2.66	5.31	7.97	10.63	13.28	15.94	18.59	21.25	23.91	26.56	29.22	31.88	34.53	37.19	39.84	42.50
13	2.76	5.52	8.28	11.04	13.80	16.56	19.32	22.08	24.84	27.60	30.36	33.12	35.88	38.64	41.40	44.16
13½	2.87	5.74	8.61	11.48	14.34	17.21	20.08	22.95	25.82	28.69	31.56	34.43	37.30	40.16	43.03	45.90
14	2.98	5.95	8.93	11.90	14.88	17.85	20.83	23.80	26.78	29.75	32.73	35.70	38.68	41.65	44.63	47.60
14½	3.08	6.16	9.24	12.33	15.41	18.49	21.57	24.65	27.73	30.81	33.89	36.97	40.05	43.13	46.21	49.29
15	3.19	6.38	9.56	12.77	15.96	19.15	22.34	25.52	28.71	31.90	35.09	38.28	41.47	44.65	47.84	51.03
15½	3.29	6.59	9.88	13.18	16.47	19.76	23.06	26.35	29.64	32.94	36.23	39.52	42.82	46.11	49.40	52.7
16	3.40	6.80	10.20	13.60	17.00	20.40	23.80	27.20	30.60	34.00	37.40	40.80	44.20	47.60	51.00	54.4
16½	3.51	7.03	10.52	14.03	17.53	21.04	24.54	28.05	31.56	35.06	38.57	42.08	45.58	49.09	52.59	56.1
17	3.61	7.23	10.84	14.45	18.06	21.68	25.29	28.90	32.52	36.13	39.74	43.36	47.00	50.58	54.20	57.8
17½	3.72	7.44	11.16	14.88	18.59	22.32	26.03	29.75	33.48	37.19	40.91	44.63	48.35	52.07	55.79	59.5
18	3.82	7.65	11.48	15.30	19.13	22.95	26.78	30.60	34.43	38.26	42.08	45.91	49.73	53.56	57.38	61.2
18½	3.93	7.86	11.79	15.73	19.66	23.59	27.52	31.45	35.38	39.31	43.24	47.18	51.11	55.04	58.97	62.9
19	4.04	8.08	12.11	16.17	20.21	24.25	28.29	32.33	36.46	40.37	44.41	48.45	52.49	56.53	60.57	64.6
19½	4.14	8.29	12.43	16.58	20.72	24.86	29.01	33.15	37.29	41.44	45.58	49.72	53.86	58.01	62.15	66.3
20	4.25	8.50	12.75	17.00	21.25	25.50	29.75	34.00	38.25	42.50	46.75	51.00	55.25	59.50	63.75	68.0
20½	4.36	8.71	13.07	17.43	21.79	26.14	30.50	34.86	39.21	43.57	47.93	52.29	56.64	61.00	65.36	69.7
21	4.46	8.93	13.39	17.85	22.32	26.78	31.25	35.71	40.18	44.64	49.11	53.57	58.04	62.50	66.96	71.4
21½	4.57	9.14	13.71	18.28	22.85	27.42	32.00	36.56	41.13	45.70	50.27	54.84	59.41	63.98	68.54	73.1
22	4.68	9.35	14.03	18.70	23.38	28.05	32.73	37.40	42.08	46.75	51.43	56.10	60.78	65.45	70.13	74.8
22½	4.78	9.56	14.34	19.13	23.91	28.69	33.47	38.25	43.03	47.81	52.60	57.38	62.12	66.90	71.37	76.5
23	4.89	9.78	14.66	19.55	24.44	29.33	34.21	39.10	43.99	48.88	53.76	58.65	63.53	68.42	73.30	78.2
23½	4.99	9.99	14.98	19.98	24.97	29.96	34.96	39.95	44.94	49.93	54.92	59.91	64.91	69.90	74.89	79.9
24	5.10	10.20	15.30	20.40	25.50	30.60	35.70	40.80	45.90	51.00	56.10	61.20	66.30	71.40	76.50	81.6
24½	5.21	10.41	15.62	20.83	26.04	31.24	36.45	41.65	46.86	52.06	57.27	62.47	67.68	72.88	78.09	83.2
25	5.31	10.63	15.94	21.25	26.56	31.88	37.19	42.50	47.81	53.13	58.44	63.75	69.07	74.38	79.7	85.0
26	5.53	11.05	16.58	22.10	27.63	33.15	38.68	44.20	49.73	55.25	60.78	66.30	71.83	77.35	82.88	88.4
27	5.74	11.48	17.21	22.95	28.69	34.43	40.16	45.90	51.64	57.38	63.12	68.85	74.59	80.33	86.07	91.8
28	5.95	11.90	17.85	23.80	29.75	35.70	41.65	47.60	53.55	59.50	65.45	71.40	77.35	83.30	89.25	95.2
29	6.16	12.33	18.49	24.65	30.81	36.98	43.14	49.30	55.47	61.63	67.79	73.96	80.12	86.28	92.44	98.6
30	6.38	12.75	19.13	25.50	31.88	38.25	44.63	51.00	57.38	63.75	70.13	76.50	82.88	89.25	95.63	102.0
31	6.59	13.18	19.76	26.35	32.94	39.53	46.12	52.70	59.29	65.88	72.47	79.06	85.65	92.23	98.82	105.4
32	6.80	13.60	20.40	27.20	34.00	40.80	47.60	54.40	61.20	68.00	74.80	81.60	88.40	95.20	102.00	108.8
33	7.01	14.03	21.04	28.05	35.06	42.08	49.09	56.10	63.11	70.13	77.14	84.15	91.16	98.18	105.19	112.2
34	7.23	14.45	21.68	28.90	36.13	43.36	50.58	57.80	65.03	72.25	79.48	86.70	93.93	101.15	108.38	115.6
35	7.44	14.88	22.32	29.75	37.19	44.63	52.07	59.50	66.94	74.38	81.81	89.25	96.69	104.13	111.56	119.0
36	7.65	15.30	22.95	30.60	38.25	45.90	53.55	61.20	68.85	76.50	84.15	91.80	99.45	107.10	114.75	122.4
37	7.86	15.73	23.59	31.45	39.31	47.18	55.03	62.90	70.78	78.63	86.49	94.35	102.20	110.06	117.91	125.8
38	8.08	16.15	24.23	32.30	40.38	48.45	56.50	64.60	72.68	80.75	88.83	96.90	104.98	113.05	121.13	129.2
39	8.29	16.58	24.86	33.15	41.44	49.73	57.98	66.30	74.59	82.88	91.16	99.45	107.74	116.03	124.32	132.6
40	8.50	17.00	25.50	34.00	42.50	51.00	59.50	68.00	76.50	85.00	93.50	102.00	110.50	119.00	127.50	136.0
41	8.71	17.43	26.14	34.86	43.58	52.29	60.99	69.72	78.43	87.15	95.86	104.58	113.29	122.01	130.72	139.4
42	8.93	17.85	26.78	35.70	44.63	53.55	62.48	71.40	80.33	89.25	98.18	107.10	116.03	124.95	133.88	142.8
43	9.14	18.28	27.42	36.55	45.69	54.83	63.97	73.10	82.24	91.38	100.52	109.65	118.79	127.93	137.06	146.2
44	9.35	18.70	28.05	37.40	46.75	56.10	65.45	74.80	84.15	93.50	102.85	112.20	121.55	130.90	140.25	149.6
45	9.56	19.13	28.69	38.25	47.81	57.38	66.94	76.50	86.06	95.63	105.19	114.75	124.31	133.88	143.44	153.0
46	9.78	19.55	29.33	39.10	48.88	58.65	68.43	78.20	87.98	97.75	107.53	117.30	127.08	136.85	146.63	156.4
47	9.99	19.98	29.96	39.95	49.94	59.93	69.91	79.90	89.89	99.88	109.86	119.85	129.84	139.83	149.82	159.8
48	10.20	20.40	30.60	40.80	51.00	61.20	71.40	81.60	91.80	102.00	112.20	122.40	132.60	142.80	153.00	163.2

WEIGHTS OF FLAT ROLLED STEEL

POUNDS PER LINEAL FOOT

Width, Inches	Thickness, Inches															
	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1
49	10.4	20.8	31.2	41.7	52.1	62.5	72.9	83.3	93.7	104.1	114.5	125.0	135.4	145.8	156.2	166.6	
50	10.6	21.3	31.9	42.5	53.1	63.8	74.4	85.0	95.6	106.3	116.9	127.5	138.1	148.8	159.4	170.0	
51	10.8	21.7	32.5	43.4	54.2	65.0	75.9	86.7	97.5	108.4	119.2	130.1	140.9	151.7	162.6	173.4	
52	11.1	22.1	33.2	44.2	55.3	66.3	77.4	88.4	99.5	110.5	121.6	132.6	143.7	154.7	165.8	176.8	
53	11.3	22.5	33.8	45.1	56.3	67.6	78.8	90.1	101.4	112.6	123.9	135.2	146.4	157.7	168.9	180.2	
54	11.5	23.0	34.4	45.9	57.4	68.9	80.3	91.8	103.3	114.8	126.2	137.7	149.2	160.7	172.1	183.6	
55	11.7	23.4	35.1	46.8	58.4	70.1	81.8	93.5	105.2	116.9	128.6	140.3	151.9	163.6	175.3	187.0	
56	11.9	23.8	35.7	47.6	59.5	71.4	83.3	95.2	107.1	119.0	130.9	142.8	154.7	166.6	178.5	190.4	
57	12.1	24.2	36.3	48.5	60.6	72.7	84.8	96.9	109.0	121.1	133.2	145.4	157.5	169.6	181.7	193.8	
58	12.3	24.7	37.0	49.3	61.6	74.0	86.3	98.6	110.9	123.3	135.6	147.9	160.2	172.6	184.9	197.2	
59	12.5	25.1	37.6	50.2	62.7	75.2	87.8	100.3	112.8	125.4	137.9	150.5	163.0	175.5	188.1	200.6	
60	12.8	25.5	38.3	51.0	63.8	76.5	89.3	102.0	114.8	127.5	140.3	153.0	165.8	178.5	191.3	204.0	
61	13.0	25.9	38.9	51.9	64.8	77.8	90.7	103.7	116.7	129.6	142.6	155.6	168.5	181.5	194.4	207.4	
62	13.2	26.4	39.5	52.7	65.9	79.1	92.2	105.4	118.6	131.8	144.9	158.1	171.3	184.5	197.6	210.8	
63	13.4	26.8	40.2	53.6	66.9	80.3	93.7	107.1	120.5	133.9	147.3	160.7	174.0	187.4	200.8	214.2	
64	13.6	27.2	40.8	54.4	68.0	81.6	95.2	108.8	122.4	136.0	149.6	163.2	176.8	190.4	204.0	217.6	
65	13.8	27.6	41.4	55.3	69.1	82.9	96.7	110.5	124.3	138.1	151.9	165.8	179.6	193.4	207.2	221.0	
66	14.0	28.1	42.1	56.1	70.1	84.2	98.2	112.2	126.2	140.3	154.3	168.3	182.3	196.4	210.4	224.4	
67	14.2	28.5	42.7	57.0	71.2	85.4	99.7	113.9	128.1	142.4	156.6	170.9	185.1	199.3	213.6	227.8	
68	14.5	28.9	43.4	57.8	72.3	86.7	101.2	115.6	130.1	144.5	159.0	173.4	187.9	202.3	216.8	231.2	
69	14.7	29.3	44.0	58.7	73.3	88.0	102.6	117.3	132.0	146.6	161.3	176.0	190.6	205.3	219.9	234.6	
70	14.9	29.8	44.6	59.5	74.4	89.3	104.1	119.0	133.9	148.8	163.6	178.5	193.4	208.3	223.1	238.0	
71	15.1	30.2	45.3	60.4	75.4	90.5	105.6	120.7	135.8	150.9	166.0	181.1	196.1	211.2	226.3	241.4	
72	15.3	30.6	45.9	61.2	76.5	91.8	107.1	122.4	137.7	153.0	168.3	183.6	198.9	214.2	229.5	244.8	
73	15.5	31.0	46.5	62.1	77.6	93.1	108.6	124.1	139.6	155.1	170.6	186.2	201.7	217.2	232.7	248.2	
74	15.7	31.5	47.2	62.9	78.6	94.4	110.1	125.8	141.5	157.3	173.0	188.7	204.4	220.2	235.9	251.6	
75	15.9	31.9	47.8	63.8	79.7	95.6	111.6	127.5	143.4	159.4	175.3	191.3	207.2	223.1	239.1	255.0	
76	16.2	32.3	48.5	64.6	80.8	96.9	113.1	129.2	145.4	161.5	177.7	193.8	210.0	226.1	242.3	258.4	
77	16.4	32.7	49.1	65.5	81.8	98.2	114.5	130.9	147.3	163.6	180.0	196.4	212.7	229.1	245.4	261.8	
78	16.6	33.2	49.7	66.3	82.9	99.5	116.0	132.6	149.2	165.8	182.3	198.9	215.5	232.1	248.6	265.2	
79	16.8	33.6	50.4	67.2	83.9	100.7	117.5	134.3	151.1	167.9	184.7	201.5	218.2	235.0	251.8	268.6	
80	17.0	34.0	51.0	68.0	85.0	102.0	119.0	136.0	153.0	170.0	187.0	204.0	221.0	238.0	255.0	272.0	
81	17.2	34.4	51.6	68.9	86.1	103.3	120.5	137.7	154.9	172.1	189.3	206.6	223.8	241.0	258.2	275.4	
82	17.4	34.9	52.3	69.7	87.1	104.6	122.0	139.4	156.8	174.3	191.7	209.1	226.5	244.0	261.4	278.8	
83	17.6	35.3	52.9	70.6	88.2	105.8	123.5	141.1	158.7	176.4	194.0	211.7	229.3	246.9	264.6	282.2	
84	17.9	35.7	53.6	71.4	89.3	107.1	125.0	142.8	160.7	178.5	196.4	214.2	232.1	249.9	267.8	285.6	
85	18.1	36.1	54.2	72.3	90.3	108.4	126.4	144.5	162.6	180.6	198.7	216.8	234.8	252.9	270.9	289.0	
86	18.3	36.6	54.8	73.1	91.4	109.7	127.9	146.2	164.5	182.8	201.0	219.3	237.6	255.9	274.1	292.4	
87	18.5	37.0	55.5	74.0	92.4	110.9	129.4	147.9	166.4	184.9	203.4	221.9	240.3	258.8	277.3	295.8	
88	18.7	37.4	56.1	74.8	93.5	112.2	130.9	149.6	168.3	187.0	205.7	224.4	243.1	261.8	280.5	299.2	
89	18.9	37.8	56.7	75.7	94.6	113.5	132.4	151.3	170.2	189.1	208.0	227.0	245.9	264.8	283.7	302.6	
90	19.1	38.3	57.4	76.5	95.6	114.8	133.9	153.0	172.1	191.3	210.4	229.5	248.6	267.8	286.9	306.0	
91	19.3	38.7	58.0	77.4	96.7	116.0	135.4	154.7	174.0	193.4	212.7	232.1	251.4	270.7	290.1	309.4	
92	19.6	39.1	58.7	78.2	97.8	117.3	136.9	156.4	176.0	195.5	215.1	234.6	254.2	273.7	293.3	312.8	
93	19.8	39.5	59.3	79.1	98.8	118.6	138.3	158.1	177.9	197.6	217.4	237.2	256.9	276.7	296.4	316.2	
94	20.0	40.0	59.9	79.9	99.9	119.9	139.8	159.8	179.8	199.8	219.7	239.7	259.7	279.7	299.6	319.6	
95	20.2	40.4	60.6	80.8	100.9	121.1	141.3	161.5	181.7	201.9	222.1	242.3	262.4	282.6	302.8	323.0	
96	20.4	40.8	61.2	81.6	102.0	122.4	142.8	163.2	183.6	204.0	224.4	244.8	265.2	285.6	306.0	326.4	
97	20.6	41.2	61.8	82.5	103.1	123.7	144.3	164.9	185.5	206.1	226.7	247.4	268.0	288.6	309.2	329.8	
98	20.8	41.7	62.5	83.3	104.1	125.0	145.8	166.6	187.4	208.3	229.1	249.9	270.7	291.6	312.4	333.2	
99	21.0	42.1	63.1	84.2	105.2	126.2	147.3	168.3	189.3	210.4	231.4	252.5	273.5	294.5	315.6	336.6	
100	21.3	42.5	63.8	85.0	106.3	127.5	148.8	170.0	191.3	212.5	233.8	255.0	276.3	297.5	318.8	340.0	

A.S.C.E. RAILS AND LIGHT RAILS

Note: [illegible]

Steel railway rails in all sizes and weights, new and relaying, available for immediate delivery. Fish plates, bolts, spikes, flange sections and switch stands supplied.

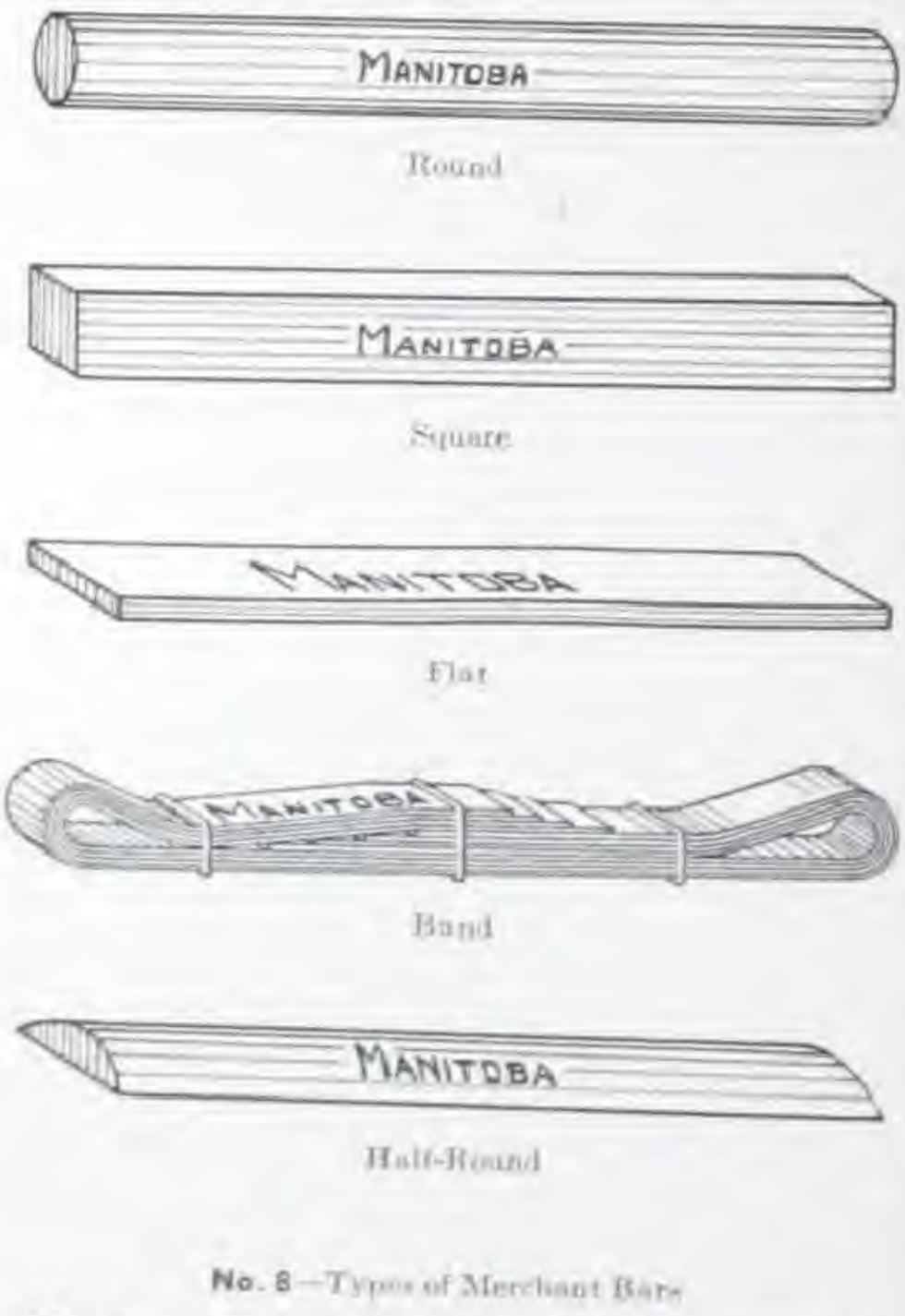
Weight per Yard. Lbs.	Weight of Rail. Lbs. per ft.	Depth of Rail. Ins.	Width of Rail. Ins.	Weights of Rail. Lbs. per Yard.	Size of Bolts. Ins.	Size of Spikes. Ins.	Weights of Plates. Lbs. per pair. Ins.		
60	41 1/2	4	2 1/2	24	3/4 x 3 1/2	5/8 x 5/8	40	402	2
56	40	4	2 1/2	24	3/4 x 3 1/2	5/8 x 5/8	38	961	2
50	35	3 7/8	2 1/2	24	3/4 x 3 1/2	5/8 x 5/8	33	961	2
45	31 1/2	3 7/8	2	20	3/4 x 3	5/8 x 5/8	14	73	2
40	28	3 1/2	1 7/8	20	3/4 x 2 1/2	5/8 x 5/8	13	73	2
35	24 1/2	3 1/2	1 7/8	18 1/2	3/4 x 2 1/2	5/8 x 5/8	13	73	1
30	21	3 1/2	1 5/8	18 1/2	3/4 x 2 1/2	5/8 x 5/8	10	85	1
25	17 1/2	2 3/4	1 1/2	16 1/2	3/4 x 2 1/2	5/8 x 5/8	8	79	
20	14	2 1/2	1 1/2	16 1/2	3/4 x 2	5/8 x 5/8	8	90	
16	11 1/2	2 1/2	1 1/2	16 1/2	3/4 x 1 3/4	5/8 x 5/8	6	20	
14	10	2 1/2	1 1/4	16 1/2	3/4 x 1 3/4	5/8 x 5/8	5	41	
12	8	2	1	16 1/2	3/4 x 1 3/4	5/8 x 5/8	5	41	
10	7 1/2	1 7/8	1	16 1/2	3/4 x 1 1/2	5/8 x 5/8	2	60	
8	6 1/2	1 5/8	1	16 1/2	3/4 x 1 1/2	5/8 x 5/8	2	00	

MERCHANT BARS

We own and operate at Selkirk, Manitoba, our own Steel Plant comprised of a basic open hearth furnace of twenty tons capacity per heat (80 tons daily) and three rolling mills, a 9-inch, a 12-inch and a 16-inch.

The furnace is of the basic type as in this kind it is possible to produce steel of uniform quality from a wider range of raw material. Fuel oil is used to generate the high temperatures necessary for melting and refining.

All the rolling mills are of the Belgian type, driven by electric motors of 500, 350 and 800 h.p. capacity.



No. 8—Types of Merchant Bars

The refined molten steel from the open hearth furnace is poured into ingots, each ingot being marked with its respective heat number. Our laboratory makes a careful analysis of each heat and this information is recorded in the office for future reference. The records will therefore show in a moment the physical properties of all of the steel which we have on hand at any time and from these we draw those suitable to customer's specifications as orders are received.

If suitable qualities are not available from storage, the furnace is operated on the grade required to enable completion of the orders as required.

We are able to supply steel to any of the standard specifications and over a period of years have enjoyed the confidence of our customers who all agree as to the uniformity and workability of the bars which we supply.

Merchant grades in both high and extremely low carbons have been supplied for all of the manufacturing processes at present being carried on in Western Canada and we can furnish any of these grades in rounds, squares, flats, bands, half rounds and ovals within the following limits:

ROUNDS
HALF ROUNDS —From $\frac{3}{8}$ inch diameter up to and including 3 inch diameter.

SQUARES—From $\frac{3}{8}$ inch square up to and including 3-inch square.

FLATS—From $\frac{3}{16}$ inch x $\frac{3}{8}$ inch up to and including $1\frac{1}{2}$ inch x 6 inch.

BANDS—From $\frac{3}{4}$ inch to 3 inch in width, and $\frac{1}{8}$ inch thick.

SQUARE AND ROUND BARS

WEIGHTS AND AREAS

Size, Inches	Weights, Lbs. per Foot		Areas, Square Inches		Size, Inches	Weights, Lbs. per Foot		Areas, Square Inches	
	□	○	□	○		□	○	□	○
0					3	30.600	24.011	9.0000	7.0686
1/16	.013	.010	.00391	.00307	1/16	31.889	25.035	9.3789	7.3662
1/8	.050	.042	.01562	.01227	1/8	33.200	26.068	9.7656	7.6699
3/16	.120	.094	.03516	.02761	3/16	34.534	27.113	10.1602	7.9798
1/4	.213	.167	.06250	.04909	1/4	35.891	28.173	10.5625	8.2958
5/16	.332	.261	.09766	.07670	5/16	37.271	29.247	10.9727	8.6179
3/8	.478	.375	.14063	.11045	3/8	38.674	30.342	11.3906	8.9462
7/16	.651	.511	.19141	.15033	7/16	40.100	31.460	11.8164	9.2806
1/2	.850	.668	.25000	.19635	1/2	41.550	32.601	12.2500	9.6211
9/16	1.076	.845	.31641	.24850	9/16	43.023	33.765	12.6914	9.9678
5/8	1.328	1.043	.39063	.30680	5/8	44.519	34.942	13.1406	10.3206
11/16	1.607	1.262	.47266	.37122	11/16	46.038	36.141	13.5977	10.6796
3/4	1.913	1.502	.56250	.44179	3/4	47.581	37.353	14.0625	11.0447
13/16	2.245	1.763	.66016	.51849	13/16	49.146	38.587	14.5352	11.4159
7/8	2.603	2.044	.76563	.60132	7/8	50.735	39.833	15.0156	11.7933
15/16	2.986	2.347	.87891	.69029	15/16	52.347	41.102	15.5039	12.1767
1	3.400	2.670	1.00000	.78540	4	53.982	42.387	16.0000	12.5664
1/16	3.828	3.006	1.12598	.88465	1/16	55.641	43.693	16.5039	12.9622
1/8	4.281	3.361	1.26563	.99402	1/8	57.323	45.016	17.0156	13.3641
3/16	4.760	3.738	1.41016	1.10772	3/16	59.028	46.361	17.5352	13.7722
1/4	5.263	4.132	1.56250	1.22718	1/4	60.757	47.720	18.0625	14.1863
5/16	5.837	4.588	1.72461	1.35481	5/16	62.509	49.098	18.5977	14.6066
3/8	6.429	5.049	1.90039	1.49265	3/8	64.284	50.491	19.1406	15.0331
7/16	7.026	5.518	2.07617	1.63070	7/16	66.083	51.906	19.6914	15.4658
1/2	7.650	6.008	2.26172	1.77671	1/2	67.905	53.335	20.2500	15.9048
9/16	8.301	6.519	2.45410	1.92728	9/16	69.750	54.781	20.8164	16.3500
5/8	8.978	7.051	2.65430	2.08385	5/8	71.618	56.250	21.3906	16.8016
11/16	9.682	7.604	2.86377	2.24886	11/16	73.511	57.735	21.9727	17.2597
3/4	10.413	8.178	3.08008	2.41963	3/4	75.427	59.243	22.5625	17.7241
13/16	11.170	8.772	3.30469	2.59640	13/16	77.367	60.768	23.1602	18.1949
7/8	11.953	9.386	3.53760	2.77915	7/8	79.332	62.309	23.7656	18.6720
15/16	12.763	10.024	3.77930	2.96863	15/16	81.321	63.868	24.3789	19.1567
2	13.600	10.681	4.00977	3.14316	5	83.335	65.441	25.0000	19.6350	19.6455
1/16	14.464	11.358	4.26074	3.34430	1/16	85.374	67.040	25.6289	20.1274
1/8	15.353	12.058	4.51660	3.54656	1/8	87.438	68.664	26.2656	20.6259
3/16	16.270	12.778	4.79102	3.76363	3/16	89.527	70.303	26.9102	21.1355
1/4	17.213	13.519	5.06250	3.97761	1/4	91.641	71.967	27.5625	21.6519
5/16	18.182	14.280	5.34277	4.19681	5/16	93.780	73.655	28.2227	22.1749
3/8	19.178	15.062	5.64160	4.43101	3/8	95.943	75.353	28.8906	22.6992
7/16	20.200	15.866	5.94141	4.66604	7/16	98.131	77.071	29.5664	23.2322
1/2	21.250	16.690	6.25000	4.90692	1/2	100.343	78.810	30.2500	23.7720
9/16	22.326	17.534	6.56836	5.15572	9/16	102.580	80.568	30.9414	24.3181
5/8	23.428	18.398	6.89648	5.41119	5/8	104.841	82.347	31.6406	24.8705
11/16	24.557	19.283	7.22437	5.67247	11/16	107.127	84.145	32.3477	25.4292
3/4	25.713	20.188	7.56223	5.93960	3/4	109.437	85.963	33.0625	25.9941
13/16	26.895	21.125	7.91016	6.21256	13/16	111.771	87.801	33.7852	26.5653
7/8	28.103	22.072	8.26758	6.49136	7/8	114.130	89.658	34.5156	27.1429
15/16	29.336	23.043	8.62598	6.77571	15/16	116.513	91.535	35.2539	27.7266

For weights of flats, see pages 18 to 20.

SQUARE AND ROUND BARS
WEIGHTS AND AREAS

Size, Inches	Weight, Lbs. per Foot		Area, Square Inches		Size, Inches	Weight, Lbs. per Foot		Area, Square Inches	
	□	○	□	○		□	○	□	○
6	122.40	96.13	36.000	28.274	9	275.40	216.30	81.000	63.617
1/16	124.96	98.15	36.754	28.866	1/16	279.24	219.31	82.129	64.504
1/8	127.55	100.18	37.516	29.465	1/8	283.10	222.35	83.266	65.397
3/16	130.17	102.23	38.285	30.069	3/16	286.99	225.41	84.410	66.296
1/4	132.81	104.31	39.063	30.680	1/4	290.91	228.48	85.563	67.201
5/16	135.48	106.41	39.848	31.296	5/16	294.86	231.58	86.723	68.112
3/8	138.18	108.53	40.641	31.919	3/8	298.83	234.70	87.891	69.029
7/16	140.90	110.66	41.441	32.548	7/16	302.83	237.84	89.066	69.953
1/2	143.65	112.82	42.250	33.183	1/2	306.85	241.00	90.250	70.882
9/16	146.43	115.00	43.066	33.824	9/16	310.90	244.18	91.441	71.818
5/8	149.23	117.20	43.891	34.472	5/8	314.98	247.38	92.641	72.760
11/16	152.06	119.43	44.723	35.125	11/16	319.08	250.61	93.848	73.708
3/4	154.91	121.67	45.563	35.785	3/4	323.21	253.85	95.063	74.662
13/16	157.79	123.93	46.410	36.450	13/16	327.37	257.12	96.285	75.622
7/8	160.70	126.22	47.266	37.122	7/8	331.55	260.40	97.516	76.589
15/16	163.64	128.52	48.129	37.800	15/16	335.76	263.71	98.754	77.561
7	166.60	130.85	49.000	38.485	10	340.00	267.04	100.000	78.540
1/16	169.59	133.19	49.879	39.175	1/16	344.26	270.38	101.254	79.525
1/8	172.60	135.56	50.766	39.871	1/8	348.55	273.75	102.516	80.516
3/16	175.64	137.95	51.660	40.574	3/16	352.87	277.14	103.785	81.513
1/4	178.71	140.36	52.563	41.282	1/4	357.21	280.55	105.063	82.516
5/16	181.81	142.79	53.473	41.997	5/16	361.58	283.99	106.348	83.525
3/8	184.93	145.24	54.391	42.718	3/8	365.98	287.44	107.641	84.541
7/16	188.07	147.71	55.316	43.445	7/16	370.40	290.91	108.941	85.563
1/2	191.25	150.21	56.250	44.179	1/2	374.85	294.41	110.250	86.590
9/16	194.45	152.72	57.191	44.918	9/16	379.33	297.92	111.566	87.624
5/8	197.68	155.26	58.141	45.664	5/8	383.83	301.46	112.891	88.664
11/16	200.93	157.81	59.098	46.415	11/16	388.36	305.02	114.223	89.710
3/4	204.21	160.39	60.063	47.173	3/4	392.91	308.59	115.563	90.763
13/16	207.52	162.99	61.035	47.937	13/16	397.49	312.19	116.910	91.821
7/8	210.85	165.60	62.016	48.707	7/8	402.10	315.81	118.266	92.886
15/16	214.21	168.24	63.004	49.483	15/16	406.74	319.45	119.629	93.957
8	217.60	170.90	64.000	50.265	11	411.40	323.13	121.000	95.033
1/16	221.01	173.58	65.004	51.054	1/16	416.09	326.80	122.379	96.116
1/8	224.45	176.29	66.016	51.849	1/8	420.80	330.50	123.766	97.205
3/16	227.92	179.01	67.035	52.649	3/16	425.54	334.22	125.160	98.301
1/4	231.41	181.75	68.063	53.456	1/4	430.31	337.97	126.563	99.402
5/16	234.93	184.52	69.098	54.269	5/16	435.11	341.73	127.973	100.510
3/8	238.48	187.30	70.141	55.088	3/8	439.93	345.52	129.391	101.623
7/16	242.05	190.11	71.191	55.914	7/16	444.78	349.33	130.816	102.743
1/2	245.65	192.93	72.250	56.745	1/2	449.65	353.16	132.250	103.869
9/16	249.28	195.78	73.316	57.583	9/16	454.55	357.01	133.691	105.001
5/8	252.93	198.65	74.391	58.426	5/8	459.48	360.87	135.141	106.139
11/16	256.61	201.54	75.473	59.276	11/16	464.43	364.76	136.598	107.284
3/4	260.31	204.45	76.563	60.132	3/4	469.41	368.68	138.063	108.434
13/16	264.04	207.38	77.660	60.994	13/16	474.42	372.61	139.535	109.591
7/8	267.80	210.33	78.766	61.863	7/8	479.45	376.56	141.016	110.754
15/16	271.59	213.31	79.879	62.737	15/16	484.51	380.54	142.504	111.923
					12	489.60	384.53	144.000	113.098

For weights of flats, see pages 18 to 20.

DIMENSIONS AND WEIGHTS OF SMALL CHANNELS FOR REINFORCING.

Pacific end, looking East, of Cantilever Bridge over the Fraser River at Prince George, Erected and Painted by the Manitoba Bridge and Iron Works, Limited.

LINTELS

In determining the loads imposed on lintels, the clear width of opening, thickness of wall, material of which constructed, and whether any weight except the wall above is carried, must be taken into consideration. If the wall is solid, with no window openings above the lintel, the wall will arch and carry a great deal of load to the adjoining wall which supports the lintel, without coming on the lintel. The portion for which the lintel should be designed would be a triangle whose height will be one-half the span. This is true only when the adjoining wall is sufficient to take the thrust due to the arch effect.

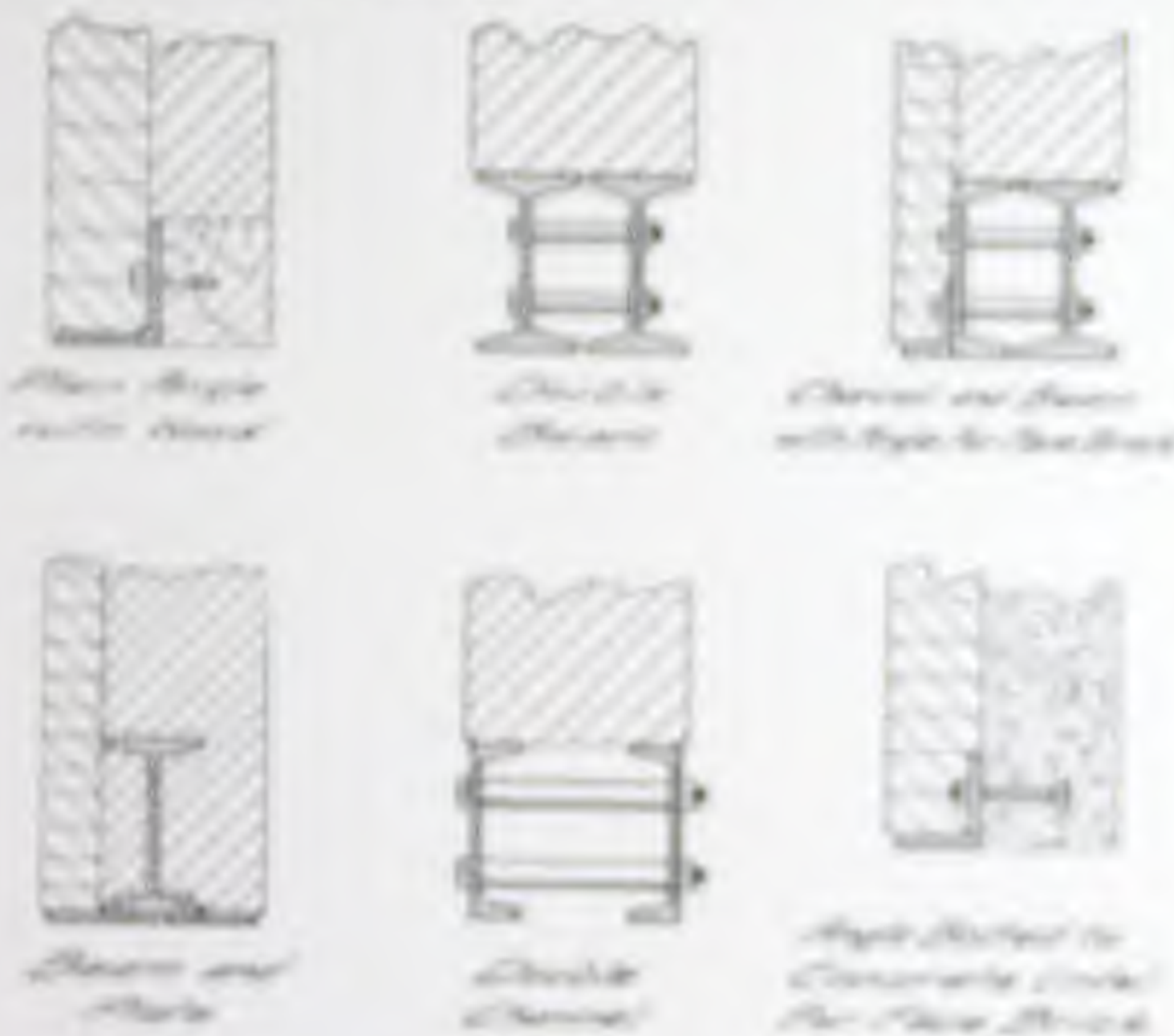


Fig. 10 (Types of Steel Lintels.

Each individual case must stand on its own merits and the lintel be designed accordingly. If the loads are unsymmetrical, cracks are liable to appear in walls.

The diagrams above illustrate some different types of steel lintels. Lintels made of cast iron are not in general use in present-day construction, although we have a number of patterns, and can supply cast iron lintels if desired.

FLOORS AND FLOOR LOADS

Kinds of Loads.—Two kinds of loads are carried by structures. Live loads consist of the weight of machinery, merchandise, persons or other moving objects, or of cranes or other handling devices and their loads, the support of which is the purpose of the structure, including also wind stresses. Dead loads consist of the actual weight of the structure itself with the walls, floors, partitions, roofs, and all other permanent construction and fixtures. The dead loads stress the structure at all times and it must, therefore, be proportioned to sustain them at all times without reduction. The live loads may be taken at their full values or reduced in accordance with the probabilities that the structure as a whole or its principal members will not be subject at all times to the full theoretical live loading.

Dead Loads.—The permanent load should be calculated from known weights per unit of the material composing floors, partitions, walls, or other permanent construction. The weight assumed for the steel frame itself should be checked after the sections are determined and then the sizes readjusted if necessary.

Live Loads.—Live loads vary with the character of the structures. In buildings they consist of uniform loads per square foot of floor area, concentrated loads such as heavy safes, which may be applied at any point of the floor, and uniform loads per lineal foot of beams or girders. The load which produces the maximum bending moment or reaction is to be used in proportioning sections. The floor system between beams must of course be of sufficient strength to transmit any concentrated load to the beam.

In cities the minimum live loads to be used on the various classes of buildings are fixed by public ordinances, and are given on page 31 for the principal cities of the United States in accordance with the most recent building laws, which are intended to cover general conditions and do not include machinery or other concentrations. If such concentrations, like safes, armatures, generators, or printing presses, occur on floors, special provision should be made for them in the floor framing. Flat roofs of buildings which may be loaded with people, should be treated the same as floors and the same uniform live loads used as given in the table for dwellings, hotels or assembly rooms.

Reduced Live Loads.—Floor beams in buildings should be computed to sustain floor by floor the full live and dead loads. It is not probable that all the floors will be fully loaded at all times, and, therefore, good practice permits a reduction of the theoretical live load in the computations of column sections. See pages 54 and 55.

BEARING PLATES

In the case where beams rest on walls, the table on page 51 gives sizes and thicknesses which depend on the end reaction, length of bearing and safe unit pressure for the different constructions of walls, and the dimensions given are for beams of usual spans.

MINIMUM LIVE LOADS FOR FLOORS AND ROOFS

IN POUNDS PER SQUARE FOOT

By Building Laws of Various U.S. Cities.

	Atlanta	Baltimore	Boston	Chicago	Cincinnati	Cleveland	Detroit	Milwaukee	New York
Floors for Rooms									
Apartments and Dwellings	40	40	70	40	60	70	40*	40	40
Asylums, Hospitals, etc.	40	40	70	40	60			40	40
Factories, Buildings, etc.	120	40			50	80			100
Factories:									
Light manufacturing	120	120	120	100	120		120	120	100
Heavy manufacturing			150	150	250		175		150
Hotels, Lodging Houses	60	40	70	40	60	60	40	60	40
Office Buildings, etc.	80	40	100	100	75	75	75	75	100
Public Buildings:									
Municipal Buildings	100				75	100			100
Churches	100	100	100	75	100	90	75	100	100
Libraries, Museums	100				100	125		100	
Theatres	100	100	100	100	100	80	75	100	100
Schools, Colleges, etc.	75	75		75	60	100	75	75	40
Stores, light goods	120	100	100	100	120	100	100	120	100
heavier goods			150	150	250		175		150
Warehouses			150	150	250		250	250	150
Floors for Assembly Halls									
Auditoriums, fixed seats	100	100	100	100	100	100	75	125	100
movable seats	100	100	120	100	100	100	100	125	100
Armories, Drill Halls, etc.	100	100			100	120		100	100
Miscellaneous									
Garages, Public	100	100		100	100	100	150		75
Garages, (Motorcycle	100	100		100	75	100			100
Stairways, Fire Escapes	100	100		100	75	100			100
Sidewalks	400				300	400	400		300
Roofs:									
Flat, slope up to 20° (1 in	40	30	100	40	50	100	40	40	20
Slopes, slope over 20° (1 in	30	20	80		20	50	30	30	20
Wind Pressure	30	30	50	30	20	20	30	20	30

*Floor Slopes: St. Louis, 100; Boston, 125; Cleveland, 120; Baltimore, 200; Cincinnati, 100.

†Wind pressure for high buildings in localities designated as [illegible]

EXPLANATION OF
TABLES OF SAFE LOADS

The following tables give the greatest safe load (uniformly distributed over the entire length) which the steel shapes used as beams will carry.

These loads include the weight of the beam, which must be deducted to obtain the net load.

The loads given are based on a fiber stress of 16,000 pounds per square inch, and are entirely reliable for ordinary conditions where loads are quiescent, as in buildings.

For fluctuating loads causing vibration, especially if the beams are long as compared to their depth, the tabular loads should be reduced one-fifth; for rapidly moving loads, or where loads are suddenly applied with slight impact, the tabular loads should be reduced one-third.

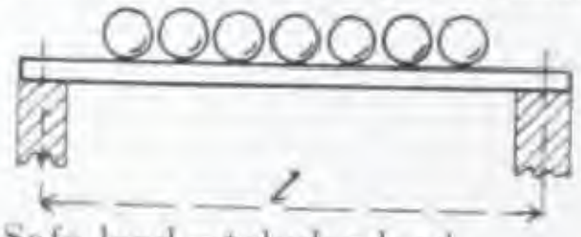
It is assumed that the beams are stiffened sideways to prevent buckling in the compression flange, otherwise tabular load must be reduced as follows.

Unbraced Length of Beam	Proportion to be used	Unbraced Length of Beam	Proportion to be used
10×flange width	Full tabular load	30×flange width	63% tabular load
15×flange width	91% tabular load	35×flange width	53% tabular load
20×flange width	81% tabular load	40×flange width	44% tabular load
25×flange width	72% tabular load	45×flange width	

In many cases deflection will govern. The allowable deflection for plastered ceilings is 1/360 of the span. The deflection will be reduced in the same ratio as the load on the beam.

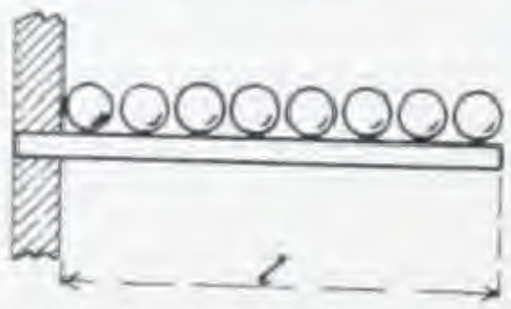
The bending moments and deflections of beams under various systems of loading are given below:

W = total load. l = length of beam. M = maximum bending moment.



Safe load = tabular load.
M at center = 1/8 Wl.
Deflection as in tables.

Safe load = 1/2 tabular load.
M = 1/4 Wl.
Deflection = .8 tabular deflection.

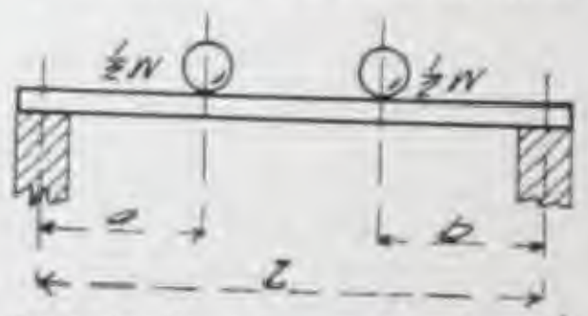


Safe load = 1/4 tabular load.
M = 1/2 Wl.
Deflection = 2.4 tabular deflection.

Safe load = 1/8 tabular load.
M at point of support = W.
Deflection = 3.2 tabular deflection.

Safe load = tabular load $\times \frac{l^2}{8ab}$

$M = \frac{Wab}{l}$



Safe load = tabular load $\times \frac{l}{4a}$

M between loads = 1/2 Wa.

BEAMS

BEAMS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections												Coefficient of Deflection
	20-Inch								18-Inch				
	100 lbs.	95 lbs.	90 lbs.	85 lbs.	81.4 lbs.	75 lbs.	70 lbs.	65.4 lbs.	90 lbs.	85 lbs.	80 lbs.	75.6 lbs.	
	349.2	**320.0**	**290.4**			**256.4**	**226.8**		**286.6**	**257.0**			
6	293.0	284.4	275.6	**261.2**	**240.0**	224.6	215.9	**200.0**	248.2	240.3	**227.5**	**201.6**	0.60
7	251.2	243.8	236.2	228.8	223.4	192.5	185.0	178.2	212.7	205.9	199.2	193.3	0.81
8	219.8	213.3	206.7	200.2	195.5	168.5	161.9	155.9	186.2	180.2	174.3	169.2	1.06
9	195.4	189.6	183.8	178.0	173.8	149.7	143.9	138.6	165.5	160.2	155.0	150.4	1.34
10	175.8	170.6	165.4	160.2	156.4	134.8	129.5	124.7	148.9	144.2	139.5	135.3	1.66
11	159.9	155.1	150.3	145.6	142.2	122.5	117.7	113.4	135.4	131.1	126.7	123.0	2.00
12	146.5	142.2	137.8	133.5	130.3	112.3	107.9	104.0	124.1	120.2	116.2	112.8	2.38
13	135.2	131.2	127.2	123.2	120.3	103.7	99.6	96.0	114.5	110.9	107.3	104.1	2.80
14	125.6	121.9	118.1	114.4	111.7	96.3	92.5	89.1	106.4	103.0	99.6	96.7	3.24
15	117.2	113.7	110.3	106.8	104.3	89.9	86.3	83.2	99.3	96.1	93.0	90.2	3.72
16	109.9	106.6	103.4	100.1	97.8	84.2	81.0	78.0	93.1	90.1	87.2	84.6	4.24
17	103.4	100.4	97.3	94.2	92.0	79.3	76.2	73.4	87.6	84.8	82.0	79.6	4.78
18	97.7	94.8	91.9	89.0	86.9	74.9	72.0	69.3	82.7	80.1	77.5	75.2	5.36
19	92.5	89.8	87.0	84.3	82.3	70.9	68.2	65.7	78.4	75.9	73.4	71.2	5.98
20	87.9	85.3	82.7	80.1	78.2	67.4	64.8	62.4	74.5	72.1	69.7	67.7	6.62
21	83.7	81.3	78.8	76.3	74.5	64.2	61.7	59.4	70.9	68.7	66.4	64.4	7.30
22	79.9	77.6	75.2	72.8	71.1	61.3	58.9	56.7	67.7	65.5	63.4	61.5	8.01
23	76.4	74.2	71.9	69.7	68.0	58.6	56.3	54.2	64.7	62.7	60.6	58.8	8.76
24	73.3	71.1	68.9	66.7	65.2	56.2	54.0	52.0	62.1	60.1	58.1	56.4	9.53
25	70.3	68.3	66.2	64.1	62.6	53.9	51.8	49.9	59.6	57.7	55.8	54.1	10.35
26	67.6	65.6	63.6	61.6	60.2	51.8	49.8	48.0	57.3	55.4	53.6	52.0	11.19
27	65.1	63.2	61.2	59.3	57.9	49.9	48.0	46.2	55.2	53.4	51.6	50.1	12.07
28	62.8	60.9	59.0	57.2	55.9	48.1	46.3	44.6	53.2	51.5	49.8	48.3	12.98
29	60.6	58.8	57.0	55.2	53.9	46.5	44.7	43.0	51.4	49.7	48.1	46.7	13.92
30	58.6	56.9	55.1	53.4	52.1	44.9	43.2	41.6	49.6	48.1	46.5	45.1	14.90
31	56.7	55.0	53.4	51.7	50.5	43.5	41.8	40.2	48.5	46.5	45.0	43.7	15.91
32	54.9	53.3	51.7	50.1	48.9	42.1	40.5	39.0	46.0	45.1	43.6	42.3	16.95
33	53.3	51.7	50.1	48.5	47.4	40.8	39.2	37.8	45.1	43.7	42.3	41.0	18.03
34	51.7	50.2	48.6	47.1	46.0	39.6	38.1	36.7	43.8	42.4	41.0	39.8	19.13
35	50.2	48.8	47.2	45.8	44.7	38.5	37.0	35.6	42.5	41.2	39.9	38.7	20.28
36	48.8	47.4	45.9	44.5	43.4	37.4	36.0	34.7	41.4	40.0	38.7	37.6	21.45
37	47.5	46.1	44.7	43.3	42.3	36.4	35.0	33.7	*40.2*	*39.0*	*37.7*	*36.6*	22.66
38	46.3	44.9	43.5	42.1	41.2	35.5	34.1	32.8	*39.2*	*37.9*	*36.7*	*35.6*	23.90
39	45.1	43.8	42.4	41.3	40.1	34.6	33.2	32.0					25.18
40	44.0	42.7	41.3	40.0	39.1	33.7	32.4	31.2					26.48
41	*42.9*	*41.6*	*40.3*	*39.1*	*38.1*	*32.9*	*31.6*	*30.4*					27.82
42	*41.8*	*40.6*	*39.4*	*38.1*	*37.2*	*32.1*	*30.8*	*29.7*					29.20

Loads in "**heavy**" type will produce maximum allowable shear in webs.
Loads in "*italic*" type will produce excessive deflections.

BEAMS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Moment = 20,000 Pounds per Square Inch

BEAMS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Pending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections													Coefficient of Deflection
	15 in.	12-Inch							10-Inch					
	37.3 lbs.	55 lbs.	50 lbs.	45 lbs.	40.8 lbs.	35 lbs.	31.8 lbs.	27.9 lbs.	40 lbs.	35 lbs.	30 lbs.	25.4 lbs.	22.4 lbs.	
3		**194 4** 189.2	**164 9**	**135 6**		**102 7**			**148 2** 112.4	**118 8** 103.7	**89 4**			0.15
4		141.9	134.1	126.3	**110 4**	100.9	**84 0**		84.3	77.7	71.2	**62 0**	**50 4**	0.27
5		113.5	107.2	101.0	95.6	80.7	76.7		67.4	62.2	57.0	52.1	48.5	0.41
	99 6							**68 2**						
6	96.1	94.6	89.4	84.2	79.7	67.3	63.9	59.1	56.2	51.8	47.5	43.4	40.4	0.60
7	82.4	81.1	76.6	72.1	68.3	57.6	54.8	50.6	48.1	44.4	40.7	37.2	34.6	0.81
8	72.1	71.0	67.0	63.1	59.8	50.5	48.0	44.3	42.1	38.9	35.6	32.6	30.3	1.06
9	64.1	63.1	59.6	56.1	53.1	44.9	42.6	39.4	37.5	34.6	31.6	28.9	26.9	1.34
10	57.7	56.8	53.6	50.5	47.8	40.4	38.4	35.5	33.7	31.1	28.5	26.0	24.2	1.66
11	52.4	51.6	48.7	45.9	43.5	36.7	34.9	32.2	30.6	28.3	25.9	23.7	22.0	2.00
12	48.1	47.3	44.7	42.1	39.8	33.6	32.0	29.5	28.1	25.9	23.7	21.7	20.2	2.38
13	44.4	43.7	41.2	38.8	36.8	31.0	29.5	27.3	25.9	23.9	21.9	20.0	18.6	2.80
14	41.2	40.6	38.3	36.1	34.2	28.8	27.4	25.3	24.1	22.2	20.3	18.6	17.3	3.24
15	38.4	37.8	35.7	33.7	31.9	26.9	25.6	23.6	22.5	20.7	19.0	17.4	16.2	3.72
16	36.0	35.5	33.5	31.6	29.9	25.2	24.0	22.2	21.1	19.4	17.8	16.3	15.1	4.24
17	33.9	33.4	31.5	29.7	28.1	23.7	22.6	20.9	19.8	18.3	16.8	15.3	14.3	4.78
18	32.0	31.5	29.8	28.1	26.6	22.4	21.3	19.7	18.7	17.3	15.8	14.5	13.5	5.36
19	30.4	29.9	28.2	26.6	25.2	21.2	20.2	18.7	17.7	16.4	15.0	13.7	12.8	5.98
20	28.8	28.4	26.8	25.3	23.9	20.2	19.2	17.7	16.9	15.5	14.2	13.0	12.1	6.62
21	27.5	27.0	25.5	24.0	22.8	19.2	18.3	16.9	*16.1*	*14.8*	*13.6*	*12.4*	*11.6*	7.30
22	26.2	25.8	24.4	23.0	21.7	18.3	17.4	16.1	*15.3*	*14.1*	*12.9*	*11.8*	*11.0*	8.01
23	25.1	24.7	23.3	22.0	20.8	17.5	16.7	15.4						8.76
24	24.0	23.7	22.3	21.0	19.9	16.8	16.0	14.8						9.53
25	23.1	*22.7*	*21.4*	*20.2*	*19.1*	*16.1*	*15.3*	*14.2*						10.35
26	22.2	*21.8*	*20.6*	*19.4*	*18.4*	*15.5*	*14.8*	*13.6*						11.19
27	21.4													12.07
28	20.6													12.98
29	19.9													13.92
30	19.2													14.90
31	*18.6*													15.91
32	*18.0*													16.95

Loads in "**heavy**" type will produce maximum allowable shear in webs.
Loads in "*italic*" type will produce excessive deflections.

BEAMS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress 16,000 Pounds per Square Inch

† Used in "Heavy" Table A.S. standard beams, although does not so state.

‡ Used in "Heavy" Table A.S. standard channels, although does not so state.

H - BEAMS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Pending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections								Coefficients of Deflection
	8-Inch			6-Inch			5-Inch	4-Inch	
	37.7 lb.	34.3 lb.	32.6 lb.	26.7 lb.	24.1 lb.	22.8 lb.	18.9 lb.	13.8 lb.	
								25 0	
3				**52 5**			**31.3**	19.0	0.15
4	**80 0**			42.1	**37.5**		25.4	14.3	0.27
5	64.4	**60.0**		33.7	32.1	**30 0**	20.3	11.4	0.41
6	53.7	51.4	**50 0**	28.1	26.7	26.1	16.9	9.5	0.60
7	46.0	44.0	43.0	24.1	22.9	22.3	14.5	8.1	0.81
8	40.3	38.5	37.6	21.1	20.1	19.6	12.7	7.1	1.06
9	35.8	34.2	33.4	18.7	17.8	17.4	11.3	*6.3*	1.34
10	32.2	30.8	30.1	16.8	16.0	15.6	10.1	*5.7*	1.66
11	29.3	28.0	27.3	15.3	14.6	14.2	*9.2*		2.00
12	26.8	25.7	25.1	14.0	13.4	13.0	*8.5*		2.38
13	24.8	23.7	23.1	*13.0*	*12.3*	*12.0*			2.80
14	23.0	22.0	21.5	*12.0*	*11.5*	*11.2*			3.24
15	21.5	20.5	20.1						3.72
16	20.1	19.3	18.8						4.24
17	*18.9*	*18.1*	*17.7*						4.78
18	*17.9*	*17.1*	*16.7*						5.36

Loads in "**heavy**" type will produce maximum allowable shear in webs.
Loads in "*italic*" type will produce excessive deflections.

CHANNELS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections												Coefficient of Deflection
	15-Inch						13-Inch						
	55 lbs.	50 lbs.	45 lbs.	40 lbs.	35 lbs.	33.9 lbs.	50 lbs.	45 lbs.	40 lbs.	37 lbs.	35 lbs.	31.8 lbs.	
	244.2	**214.8**	**185.4**				**204.6**	**175.0**					
3	203.4	190.4	177.2	**156.0**	**126.6**	**120.0**	171.2	159.8	**145.6**	**127.9**	**116.2**	**97.5**	0.15
4	152.5	142.8	132.9	123.1	113.3	111.1	128.4	119.8	111.3	106.2	102.8	97.4	0.27
5	122.0	114.3	106.3	98.5	90.7	88.9	102.7	95.9	89.1	85.0	82.3	77.9	0.41
6	101.7	95.2	88.6	82.1	75.6	74.1	85.6	79.9	74.2	70.8	68.6	65.0	0.60
7	87.1	81.6	75.9	70.3	64.7	63.5	73.3	68.4	63.6	60.6	58.8	55.7	0.81
8	76.3	71.4	66.5	61.6	56.7	55.6	64.2	59.9	55.7	53.1	51.4	48.7	1.06
9	67.8	63.5	59.1	54.7	50.4	49.4	57.1	53.2	49.5	47.2	45.7	43.3	1.34
10	61.0	57.1	53.2	49.3	45.3	44.5	51.3	47.9	44.5	42.5	41.1	39.0	1.66
11	55.5	51.9	48.3	44.8	41.2	40.4	46.7	43.6	40.5	38.6	37.4	35.4	2.00
12	50.9	47.6	44.3	41.1	37.7	37.0	42.8	39.9	37.1	35.4	34.3	32.5	2.38
13	47.0	44.0	40.9	37.9	34.9	34.2	39.5	36.9	34.3	32.7	31.6	30.0	2.80
14	43.6	40.8	38.0	35.2	32.4	31.8	36.7	34.2	31.8	30.3	29.4	27.8	3.24
15	40.7	38.1	35.5	32.8	30.2	29.6	34.2	31.9	29.7	28.3	27.4	26.0	3.72
16	38.1	35.7	33.2	30.8	28.3	27.8	32.1	30.0	27.8	26.6	25.7	24.4	4.24
17	35.9	33.6	31.3	29.0	26.7	26.1	30.2	28.2	26.2	25.0	24.2	22.9	4.78
18	33.9	31.7	29.5	27.4	25.2	24.7	28.5	26.6	24.7	23.6	22.9	21.7	5.36
19	32.1	30.1	28.0	25.9	23.9	23.4	27.0	25.2	23.4	22.4	21.6	20.5	5.98
20	30.5	28.6	26.6	24.6	22.7	22.2	25.7	24.0	22.3	21.2	20.6	19.5	6.62
21	29.1	27.2	25.3	23.5	21.6	21.2	24.5	22.8	21.2	20.2	19.6	18.6	7.30
22	27.7	26.0	24.2	22.4	20.6	20.2	23.3	21.8	20.2	19.3	18.7	17.7	8.01
23	26.5	24.8	23.1	21.4	19.7	19.3	22.3	20.8	19.4	18.5	17.9	16.9	8.76
24	25.4	23.8	22.2	20.5	18.9	18.5	21.4	20.0	18.6	17.7	17.1	16.2	9.53
25	24.4	22.9	21.3	19.7	18.1	17.8	20.5	19.2	17.8	17.0	16.5	15.6	10.35
26	23.5	22.0	20.5	18.9	17.4	17.1	19.8	18.4	17.1	16.3	15.8	15.0	11.19
27	22.6	21.2	19.7	18.2	16.8	16.5	*19.4*	*17.7*	*16.5*	*15.7*	*15.2*	*14.4*	12.07
28	21.8	20.4	19.0	17.6	16.2	15.9	*18.3*	*17.1*	*15.9*	*15.2*	*14.7*	*13.9*	12.98
29	21.0	19.7	18.3	17.0	15.6	15.3	.....	.....	.....	.....	.....	.....	13.92
30	20.3	19.0	17.7	16.4	15.1	14.8	.....	.....	.....	.....	.....	.....	14.90
31	*19.7*	*18.4*	*17.2*	*15.9*	*14.6*	*14.3*							15.91
32	*19.1*	*17.9*	*16.6*	*15.4*	*14.2*	*13.9*	.....	.....	.....	.....	.....	.....	16.93

Loads in "**heavy**" type will produce maximum allowable shear in webs.
Loads in "*italic*" type will produce excessive deflections.

CHANNELS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections										Coefficient of Deflection
	12-Inch					10-Inch					
	40 lbs.	35 lbs.	30 lbs.	25 lbs.	20.7 lbs.	35 lbs.	30 lbs.	25 lbs.	20 lbs.	15.3 lbs.	
	181.2					**164.0**	**134.6**	**105.2**			
2	174.7	**151.7**	**122.4**	**92.9**		122.9	109.8	96.8	**75.8**	**48.0**	0.07
3	116.4	105.9	95.5	85.0	**67.2**	81.9	73.2	64.5	55.8	47.6	0.15
4	87.3	79.5	71.7	63.8	56.9	61.4	54.9	48.4	41.8	35.7	0.27
5	69.9	63.6	57.3	51.0	45.5	49.2	43.9	38.7	33.5	28.5	0.41
6	58.2	53.0	47.8	42.5	38.0	41.0	36.6	32.3	27.9	23.8	0.60
7	49.9	45.4	40.9	36.4	32.5	35.1	31.4	27.6	23.9	20.4	0.83
8	43.7	39.7	35.8	31.9	28.5	30.7	27.5	24.2	20.9	17.8	1.06
9	38.8	35.3	31.8	28.3	25.3	27.3	24.4	21.5	18.6	15.9	1.34
10	34.9	31.8	28.7	25.5	22.8	24.6	22.0	19.4	16.7	14.3	1.66
11	31.7	28.9	26.1	23.2	20.7	22.3	20.0	17.6	15.2	13.0	2.00
12	29.1	26.5	23.9	21.3	19.0	20.5	18.3	16.1	13.9	11.9	2.38
13	26.9	24.5	22.0	19.6	17.5	18.9	16.9	14.9	12.9	11.0	2.80
14	25.0	22.7	20.5	18.2	16.3	17.6	15.7	13.8	12.0	10.2	3.24
15	23.3	21.2	19.1	17.0	15.2	16.4	14.6	12.9	11.2	9.5	3.72
16	21.8	19.9	17.9	15.9	14.2	15.4	13.7	12.1	10.5	8.9	4.24
17	20.6	18.7	16.9	15.0	13.4	14.5	12.9	11.4	9.9	8.4	4.78
18	19.4	17.7	15.9	14.2	12.7	13.7	12.2	10.7	9.3	7.9	5.36
19	18.4	16.7	15.1	13.4	12.0	12.9	11.6	10.2	8.8	7.5	5.98
20	17.5	15.9	14.3	12.8	11.4	12.3	11.0	9.7	8.4	7.1	6.62
21	16.6	15.1	13.6	12.1	10.8	11.7	10.3	9.2	8.0	6.8	7.30
22	15.9	14.4	13.0	11.6	10.4	11.2	10.0	8.8	7.6	6.5	8.01
23	15.2	13.8	12.5	11.1	9.9						8.76
24	14.6	13.2	11.9	10.6	9.5						9.53
25	14.0	12.7	11.3	10.0	9.1						10.35
26	13.4	12.2	11.0	9.8	8.8						11.19

Loads to "**heavy**" type will produce maximum allowable shear in webs.
Loads in "*italic*" type will produce excessive deflections.

CHANNELS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections															Coefficients of Deflection Curve
	9-Inch				8-Inch					7-Inch						
	25 lbs.	20 lbs.	15 lbs.	13.4 lbs.	21.25 lbs.	18.75 lbs.	16.25 lbs.	13.75 lbs.	11.5 lbs.	19.75 lbs.	17.25 lbs.	14.75 lbs.	12.25 lbs.	9.8 lbs.		
	110 2	**80 6**			**92 6**	**77 9**	**63 2**	**48 5**		**88 1**	**73 4**	**58 7**	**44 0**			
2	83 6	71 8	**51 3**	**41 4**	69 5	58 3	53 0	47 8	**35 2**	66 4	43 8	41 2	36 7	**29 4**	0.67	
3	55 7	47 8	40 0	37 1	42 5	38 8	35 3	31 9	28 7	33 6	30 7	27 5	24 4	21 8	0.0	1.5
4	41 8	35 9	30 0	28 0	31 7	29 1	26 5	23 9	21 5	25 2	22 4	20 6	18 3	16 4	0.0	2.7
5	33 4	28 7	24 0	22 4	25 4	23 3	21 2	19 1	17 2	20 2	18 3	16 5	14 7	13 1	0.0	4.1
6	27 9	23 9	20 0	18 7	21 2	19 4	17 7	15 9	14 4	16 8	15 2	13 7	12 2	10 9	0.0	6.0
7	23 9	20 5	17 2	16 0	18 1	16 6	15 1	13 7	12 3	14 4	13 1	11 7	10 5	9 3	0.0	8.1
8	20 9	17 9	15 0	14 0	15 9	14 6	13 3	11 9	10 8	12 6	11 5	10 3	9 2	8 2	0.1	10.6
9	18 6	16 0	13 3	12 5	14 1	12 9	11 8	10 6	9 6	11 2	10 2	9 2	8 2	7 3	0.1	13.4
10	16 7	14 4	12 0	11 2	12 7	11 7	10 6	9 6	8 6	10 1	9 2	8 3	7 4	6 6	0.1	16.6
11	15 2	13 1	10 9	10 2	11 5	10 6	9 6	8 7	7 8	9 2	8 3	7 5	6 7	5 9	0.2	20.1
12	13 9	12 0	10 0	9 3	10 6	9 7	8 8	8 0	7 2	8 4	7 6	6 9	6 1	5 5	0.2	23.9
13	12 9	11 0	9 2	8 6	9 8	9 0	8 2	7 4	6 6	7 8	7 0	6 3	5 6	4 11	0.2	28.1
14	11 9	10 3	8 6	8 0	9 1	8 3	7 6	6 8	6 2	7 2	6 6	5 10	5 2	4 8	0.3	32.6
15	11 1	9 6	8 0	7 5	8 5	7 8	7 1	6 4	5 7	6 7	6 1	5 4	4 10	4 4	0.3	37.3
16	10 4	9 0	7 5	7 0	7 9	7 3	6 6	6 0	5 4	6 2	5 6	5 0	4 6	4 0	0.4	42.4
17	9 8	8 4	7 1	6 6	7 5	6 9	6 2	5 8	5 1						0.4	47.7
18	9 3	8 0	6 7	6 3	7 1	6 5	5 9	5 4	4 9						0.5	53.3
19	8 8	7 6	6 4	6 0											0.5	59.2
20	8 4	7 3	6 0	5 8											0.6	65.3

Span in Feet	Depth and Weight of Sections												Coefficients of Deflection Curve
	6-Inch				5-Inch			4-Inch			3-Inch				
	13.5 lbs.	10 lbs.	10.5 lbs.	8.2 lbs.	14.75 lbs.	9 lbs.	6.7 lbs.	7.25 lbs.	6.25 lbs.	5.4 lbs.	6 lbs.	5 lbs.	3.5 lbs.		
					47 2			**25 6**			**21 4**	**15 5**			
1	**67 1**	**52 4**	**37 7**	**24 0**	44 3	**32 8**	**19 6**	24 3	**19 8**	**14 4**	14 7	13 0	**10 2**	0.0	0.5
2	34 6	30 7	26 8	23 1	22 1	18 8	15 8	12 1	11 1	10 1	7 3	6 5	5 8	0.0	2.0
3	23 1	20 5	17 8	15 4	14 7	12 5	10 5	8 1	7 4	6 7	4 9	4 3	3 9	0.0	4.5
4	17 3	15 4	13 4	11 6	11 0	9 4	7 9	6 1	5 5	5 1	3 7	3 3	2 9	0.0	8.0
5	13 8	12 3	10 7	9 2	8 8	7 5	6 3	4 9	4 4	4 1	2 9	2 6	2 3	0.0	12.5
6	11 5	10 2	8 9	7 7	7 4	6 3	5 3	4 1	3 7	3 4	2 4	2 2	1 10	0.0	18.0
7	9 9	8 8	7 6	6 6	6 3	5 4	4 5	3 5	3 2	2 9	2 1	1 11	1 7	0.0	24.5
8	8 6	7 7	6 7	5 8	5 5	4 7	4 0	3 0	2 9	2 6	1 9	1 7	1 5	0.0	32.0
9	7 7	6 8	5 9	5 1	4 9	4 2	3 5	2 7	2 5	2 3				0.0	40.5
10	6 9	6 1	5 3	4 6	4 4	3 8	3 2	2 4	2 2	2 0				0.0	50.0
11	6 3	5 6	4 9	4 2	4 0	3 5	2 11							0.0	60.5
12	5 8	5 1	4 5	3 10	3 8	3 1	2 8							0.0	72.0
13	5 3	4 7	4 1	3 7										0.0	84.5
14	4 11	4 4	3 10	3 4										0.0	98.0

Loads in "**heavy**" type will produce maximum allowable skew* to web.
Loads in "light" type will produce maximum deflection.

STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Equal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Neutral Axis Parallel to Either Leg

For safe loads and deflections under various systems of loading, see explanation on page 32.

Size of Angle, Inches	Weight per Foot	Distance between Supports in Feet														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8 ×8 ×1	51.00		84240	56160	42120	33700	28080	24070	21060	18720	16850	15320	**14040**	**12960**	**12030**	**11230**
$\frac{7}{8}$	45.00		74740	49840	37370	29900	24920	21360	18690	16610	14950	13590	**12460**	**11500**	**10680**	**9970**
$\frac{3}{4}$	38.90		64980	43320	32490	25990	21660	18570	16250	14440	13000	11820	**10830**	**10000**	**9280**	**8660**
$\frac{5}{8}$	32.70		54240	36620	27470	21980	18310	15700	13740	12240	10990	9990	**9160**	**8450**	**7850**	**7330**
$\frac{1}{2}$	26.40	89240	44620	29760	22310	17850	14880	12750	11160	9920	8930	8110	**7440**	**6870**	**6380**	**5950**
6 ×6 × $\frac{7}{8}$	33.10	81440	40720	27150	20360	16290	13570	11630	10180	9050	**8140**	**7400**	**6790**	**6260**	**5820**	*5430*
$\frac{3}{4}$	28.70	71180	35540	23690	17770	14220	11850	10150	8890	7900	**7110**	**6460**	**5920**	**5470**	**5080**	*4740*
$\frac{5}{8}$	24.20	60340	30170	20120	15090	12070	10060	8620	7540	6710	**6030**	**5490**	**5030**	**4640**	**4310**	*4020*
$\frac{1}{2}$	19.60	49220	24610	16400	12300	9840	8200	7030	6150	5470	**4920**	**4470**	**4100**	**3790**	**3520**	*3280*
$\frac{3}{8}$	14.90	37640	18820	12550	9410	7530	6270	5380	4700	4180	**3760**	**3420**	**3140**	**2900**	**2690**	*2510*
5 ×5 × $\frac{3}{4}$	23.60	48320	24160	16100	12080	9660	8050	6900	6040	**5360**	**4830**	**4390**	**4020**	*3710*	*3460*	*3220*
$\frac{5}{8}$	20.00	41140	20570	13710	10280	8230	6860	5880	5140	**4570**	**4110**	**3740**	**3430**	*3160*	*2940*	*2740*
$\frac{1}{2}$	16.20	33660	16830	11220	8410	6730	5610	4810	4210	**3740**	**3370**	**3060**	**2800**	*2590*	*2400*	*2240*
$\frac{3}{8}$	12.30	25820	12910	8610	6460	5170	4310	3690	3230	**2780**	**2580**	**2350**	**2150**	*1990*	*1850*	*1720*
4 ×4 × $\frac{3}{4}$	15.70	25620	12810	8540	6410	5130	4270	3660	**3200**	**2850**	**2560**	**2330**	*2140*	*1970*	*1830*	*1710*
$\frac{1}{2}$	12.80	21060	10530	7020	5270	4210	3510	3010	**2630**	**2340**	**2110**	**1910**	*1760*	*1620*	*1500*	*1400*
$\frac{3}{8}$	9.80	16240	8120	5420	4060	3250	2710	2320	**2030**	**1810**	**1620**	**1480**	*1350*	*1250*	*1160*	*1080*
$\frac{5}{16}$	8.20	13740	6870	4580	3430	2750	2290	1960	**1720**	**1530**	**1370**	**1250**	*1140*	*1060*	*980*	*920*

For lengths in "light" type, deflection will be less than $\frac{1}{8}$"; in **"heavy"** type, more than $\frac{1}{8}$"; in *"italic"* type more than $\frac{1}{8}$".

STANDARD STEEL ANGLES

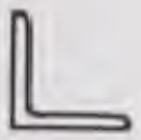
SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Equal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

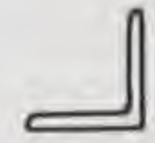
Neutral Axis Parallel to Either Leg

STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Equal Leg Angles



Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.



Neutral Axis Parallel to Either Leg

For safe loads and deflections under various systems of loading, see explanation on page 32.

Size of Angle, Inches		Weight per Foot	Distance between Supports in Feet													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3½×3½×	½	11.10	15880	7940	5290	3970	3180	2650	2270	**1098**	**1760**	*1590*	*1440*	*1320*	*1220*	*1130*	*1060*
	⅜	8.50	12280	6140	4100	3070	2460	2050	1760	**1540**	**1370**	*1239*	*1120*	*1020*	*950*	*880*	*820*
	¼	5.80	8640	4320	2880	2160	1720	1440	1230	**1080**	**960**	*860*	*780*	*720*	*660*	*610*	*570*
3 ×3 ×	½	9.40	11440	5720	3810	2860	2290	1910	**1630**	**1430**	**1270**	*1140*	*1040*	*950*	.....	.....	.....
	⅜	7.20	8880	4440	2960	2220	1780	1480	**1270**	**1110**	**990**	*890*	*810*	*740*	.....	.....	.....
	5/16	6.10	7540	3770	2510	1890	1510	1260	**1080**	**940**	**840**	*750*	*690*	*630*	.....	.....	.....
	¼	4.90	6160	3080	2050	1540	1230	1030	**880**	**770**	**680**	*620*	*560*	*510*	.....	.....	.....
2¾×2¾×	½	8.50	9480	4740	3160	2370	1900	1580	**1360**	**1190**	*1050*	*950*	*860*	*790*	.....	.....	.....
	5/16	5.60	6280	3140	2090	1570	1260	1050	**900**	**790**	*700*	*630*	*570*	*520*	.....	.....	.....
	3/16	3.39	3940	1970	1310	980	790	660	**560**	**490**	*440*	*390*	*360*	*330*	.....	.....	.....
2½×2½×	⅜	5.90	6040	3020	2010	1510	1210	1010	**860**	**760**	*670*	*600*	*550*	*500*	.....	.....	.....
	3/16	3.07	3220	1610	1080	810	650	540	**460**	**400**	*360*	*320*	*290*	*270*	.....	.....	.....
2¼×2¼×	⅜	5.30	4820	2410	1610	1210	960	**800**	**690**	*600*	*540*	*480*	*440*	*400*	.....	.....	.....
	3/16	2.75	2600	1300	870	650	520	**430**	**370**	*320*	*290*	*260*	*240*	*220*	.....	.....	.....
2 ×2 ×	⅜	4.70	3740	1870	1250	940	750	**620**	**540**	*470*	*420*	*370*	.....	.....	.....	.....	.....
	3/16	2.44	2040	1020	680	510	410	**340**	**290**	*250*	*230*	*200*	.....	.....	.....	.....	.....

For lengths in "light" type, deflection will be less than 1/360"; in **"heavy"** type, more than 1/360"; in *"italic"* type, more than 1/240".

STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Long Leg Vertical

For safe loads and deflections under various systems of loading, see explanation on page 32.

Size of Angle, Inches	Weight per Foot	Distance between Supports in Feet														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8 ×6 ×$\frac{3}{4}$	33.80	.....	62220	41480	31110	24890	20740	17770	15550	13820	12440	11310	10370	9570	8880	8290
$\frac{5}{8}$	28.50	.....	52620	35080	26310	21050	17540	15040	13150	11690	10520	9570	8770	8090	7510	7010
$\frac{1}{2}$	23.00	85480	42740	28490	21370	17090	14250	12210	10680	9500	8550	7770	7120	6570	6100	5700
7 ×3½×$\frac{5}{8}$	21.00	74280	37140	24760	18570	14850	12380	10610	9280	8250	7430	6750	6190	5710	5310	*4950*
$\frac{1}{2}$	17.00	60560	30280	20180	15140	12120	10100	8650	7570	6730	6060	5510	5050	4660	4330	*4040*
$\frac{3}{8}$	13.00	46180	23090	15390	11540	9230	7690	6590	5770	5130	4610	4190	3840	3550	3290	*3070*
6 ×4 ×$\frac{5}{8}$	20.00	56640	28320	18880	14160	11330	9440	8090	7080	6290	5660	5150	4720	4360	*4050*	*3780*
$\frac{1}{2}$	16.20	46240	23120	15410	11560	9250	7710	6600	5780	5140	4620	4200	3850	3560	*3300*	*3080*
$\frac{3}{8}$	12.30	35400	17700	11800	8850	7080	5900	5060	4420	3930	3540	3220	2950	2720	*2530*	*2360*
6 ×3½×$\frac{5}{8}$	18.90	55340	27670	18450	13840	11070	9220	7910	6920	6150	5530	5030	4610	4260	*3950*	*3690*
$\frac{1}{2}$	15.30	45200	22600	15060	11300	9040	7530	6460	5650	5020	4520	4110	3770	3480	*3230*	*3010*
$\frac{3}{8}$	11.70	34600	17300	11540	8650	6920	5770	4940	4330	3850	3460	3150	2880	2660	*2470*	*2310*
5 ×4 ×$\frac{1}{2}$	14.70	32560	16280	10850	8140	6510	5430	4650	4070	3620	3260	2960	2710	*2500*	*2330*	*2170*
$\frac{3}{8}$	11.00	25000	12500	8330	6250	5000	4170	3570	3120	2780	2500	2270	2080	*1920*	*1790*	*1670*
5 ×3½×$\frac{1}{2}$	13.60	31860	15930	10620	7960	6370	5310	4550	3980	3540	3190	2900	2650	*2450*	*2280*	*2120*
$\frac{5}{16}$	8.70	20640	10320	6880	5160	4130	3440	2950	2580	2290	2060	1880	1720	*1590*	*1470*	*1380*
5 ×3 ×$\frac{1}{2}$	12.80	31020	15510	10340	7760	6210	5170	4430	3880	3450	3100	2820	2590	*2390*	*2220*	*2070*
$\frac{5}{16}$	8.20	20120	10160	6710	5030	4020	3350	2870	2520	2240	2010	1830	1680	*1550*	*1440*	*1340*

For lengths in **"heavy"** type, the deflection will be greater than $\frac{3}{16}$"; in *"italic"* type, greater than $\frac{3}{8}$".

STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Long Leg Vertical

For safe loads and deflections under various systems of loading, see explanation on page 32.

STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Long Leg Vertical

For safe loads and deflections under various systems of loading, see explanation on page 32.

Size of Angle, Inches	Weight per Foot	Distance between Supports in Feet														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4½×3 ×½	11.90	25320	12660	8440	6330	5060	4220	3620	3170	**2810**	**2530**	**2300**	*2110*	*1950*	*1810*	*1690*
5/16	7.70	16420	8210	5470	4100	3280	2730	2340	2050	**1820**	**1640**	**1490**	*1360*	*1260*	*1170*	*1090*
4 ×3½×½	11.90	20640	10320	6880	5160	4130	3440	2950	**2580**	**2290**	**2060**	**1880**	*1720*	*1590*	*1470*	*1380*
5/16	7.70	13480	6740	4490	3370	2690	2250	1920	**1680**	**1500**	**1350**	**1220**	*1120*	*1040*	*960*	*900*
4 ×3 ×½	11.10	20140	10070	6710	5040	4030	3360	2880	**2520**	**2240**	**2010**	**1830**	*1680*	*1550*	*1440*	*1340*
5/16	7.20	13160	6580	4390	3290	2630	2190	1880	**1640**	**1460**	**1320**	**1200**	*1100*	*1010*	*940*	*880*
3½×3 ×½	10.20	15500	7750	5170	3880	3100	2580	2220	**1940**	**1720**	**1550**	*1410*	*1290*	*1190*	*1110*	*1030*
¼	5.40	8420	4210	2800	2100	1680	1400	1200	**1050**	**930**	**840**	*760*	*700*	*640*	*600*	*560*
3½×2½×½	9.40	15060	7530	5020	3760	3010	2510	2150	**1880**	**1670**	**1510**	*1370*	*1250*	*1160*	*1080*	*1000*
¼	4.90	8040	4020	2680	2010	1610	1340	1150	**1010**	**890**	**800**	*730*	*670*	*620*	*570*	*540*
3 ×2½×⅜	6.60	8640	4320	2880	2160	1730	1440	**1230**	**1080**	**960**	*860*	*790*	*720*	*660*	*620*	.....
¼	4.50	5980	2990	2000	1500	1200	1000	**860**	**750**	**670**	*600*	*540*	*500*	*460*	*430*	.....
3 ×2 ×⅜	5.90	8340	4170	2780	2080	1670	1390	**1190**	**1040**	**930**	*830*	*760*	*690*	.....	.....	.....
¼	4.10	5780	2890	1930	1440	1160	960	**830**	**720**	**640**	*580*	*530*	*480*	.....	.....	.....

For lengths in **"heavy"** type, the deflection will be greater than 3/16"; in *"italic"* type greater than 3/8".

STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Short Leg Vertical

For safe loads and deflections under various systems of loading, see explanation on page 32.

Size of Angle, Inches	Weight per Foot	Distance between Supports in Feet														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8 ×6 ×¾	33.80	73840	36920	24610	18460	14770	12310	10550	9320	8200	7380	**6710**	**6150**	**5680**	**5270**	*4920*
⅝	28.50	62680	31340	20890	15670	12530	10440	8950	7830	6960	6260	**5690**	**5220**	**4820**	**4470**	*4170*
½	23.00	55080	27540	18360	12770	10210	8510	7290	6380	5670	5100	**4640**	**4250**	**3920**	**3640**	*3400*
7 ×3½×⅝	21.00	21040	10520	7010	5260	4210	3510	3010	**2630**	**2340**	**2100**	**1910**	*1750*	*1620*	*1500*	*1400*
½	17.00	17280	8640	5760	4320	3460	2880	2470	**2160**	**1920**	**1730**	**1570**	*1440*	*1330*	*1230*	*1150*
⅜	13.00	13970	6980	4650	3490	2790	2320	1990	**1740**	**1550**	**1390**	**1270**	*1160*	*1070*	*990*	*930*
6 ×4 ×⅝	20.00	27040	13520	9020	6760	5410	4510	3860	3380	**3010**	**2700**	**2460**	*2250*	*2080*	*1930*	*1800*
½	16.20	22200	11100	7400	5550	4440	3700	3170	2770	**2470**	**2220**	**2020**	*1850*	*1710*	*1590*	*1480*
⅜	12.30	17100	8550	5700	4280	3420	2850	2440	2140	**1900**	**1710**	**1550**	*1430*	*1320*	*1220*	*1140*
6 ×3½×⅝	18.90	20680	10340	6890	5170	4140	3450	2950	**2580**	**2300**	**2070**	**1880**	*1720*	*1590*	*1480*	*1380*
½	15.30	17000	8500	5670	4250	3400	2830	2430	**2120**	**1890**	**1700**	**1550**	*1420*	*1310*	*1210*	*1130*
⅜	11.70	13140	6570	4380	3280	2630	2190	1880	**1640**	**1460**	**1310**	**1190**	*1090*	*1010*	*940*	*870*
5 ×4 ×½	14.50	21720	10860	7240	5430	4340	3620	3100	2710	**2410**	**2170**	**1970**	*1810*	*1670*	*1550*	*1450*
⅜	11.00	16740	8370	5580	4180	3350	2790	2390	2090	**1860**	**1670**	**1520**	*1390*	*1290*	*1200*	*1120*
5 ×3½×½	13.60	16640	8320	5550	4160	3330	2770	2380	**2080**	**1850**	**1660**	*1510*	*1390*	*1280*	*1190*	.....
5/16	8.70	10900	5450	3630	2720	2180	1820	1560	**1360**	**1210**	**1090**	*900*	*910*	*840*	*780*	.....
5 ×3 ×½	12.80	12220	6110	4070	3060	2440	2040	1750	**1530**	**1360**	**1220**	*1110*	*1020*	*940*	*870*	.....
5/16	8.20	8040	4020	2680	2010	1610	1340	1150	**1000**	**890**	**800**	*730*	*670*	*620*	*570*	.....

For lengths in **"heavy"** type, the deflection will be greater than 3/16"; in *"italic"* type greater than 3/8".

STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Short Leg Vertical

STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Short Leg Vertical

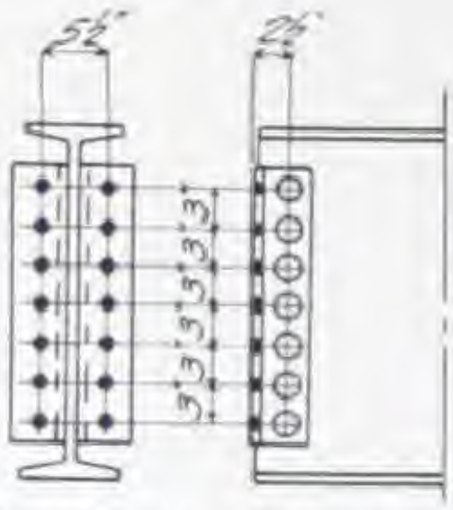
For safe loads and deflections under various systems of loading, see explanation on page 32.

Size of Angle, Inches	Weight per Foot	Distance between Supports in Feet. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
$4\frac{1}{2}\times3\times\frac{1}{2}$	11.90	12080	6040	4020	3020	2410	2010	1720	**1510**	**1340**	**1210**	*1100*	*1010*	*930*	*860*	
$\frac{5}{16}$	7.70	8106	4050	2700	2020	1620	1350	1150	**1010**	**900**	**810**	*730*	*670*	*620*	*570*	
$4\times3\frac{1}{2}\times\frac{1}{2}$	11.90	16180	8090	5390	4040	3240	2700	2310	**2020**	**1800**	**1620**	*1470*	*1350*	*1240*	*1160*	
$\frac{5}{16}$	7.70	10600	5300	3530	2650	2120	1770	1510	**1320**	**1180**	**1060**	*960*	*880*	*820*	*760*	
$4\times3\times\frac{1}{2}$	11.10	14900	5950	3960	2970	2380	1980	1700	**1490**	**1320**	**1190**	*1080*	*990*	*910*	*850*	
$\frac{5}{16}$	7.20	7840	3920	2610	1960	1570	1310	1120	**980**	**870**	**780**	*710*	*650*	*600*	*560*	
$3\frac{1}{2}\times3\times\frac{1}{2}$	10.20	11680	5840	3900	2920	2340	1950	1670	**1460**	**1300**	*1170*	*1060*	*970*	*900*	*830*	
$\frac{1}{4}$	5.40	7700	3850	2570	1930	1540	1280	1100	**960**	**860**	*770*	*700*	*640*	*590*	*550*	
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{2}$	9.40	8100	4050	2700	2030	1620	1350	**1160**	**1010**	**900**	*810*	*740*	*680*			
$\frac{1}{4}$	4.90	4400	2200	1460	1100	880	730	**630**	**550**	**490**	*440*	*400*	*370*			
$3\times2\frac{1}{2}\times\frac{3}{8}$	6.60	6200	3100	2060	1550	1240	1030	**880**	**770**	**690**	*620*	*560*	*520*			
$\frac{1}{4}$	4.50	4320	2160	1440	1080	860	720	**620**	**540**	**480**	*430*	*390*	*360*			
$3\times2\times\frac{3}{8}$	5.90	3960	1980	1320	990	790	660	**570**	**500**	*440*	*400*	*360*	*330*			
$\frac{1}{4}$	4.10	2780	1390	920	690	550	460	**400**	**350**	*310*	*280*	*250*	*230*			

For lengths in **"heavy"** type, the deflection will be greater than $\frac{1}{16}$"; in *"italic"* type greater than $\frac{3}{8}$".

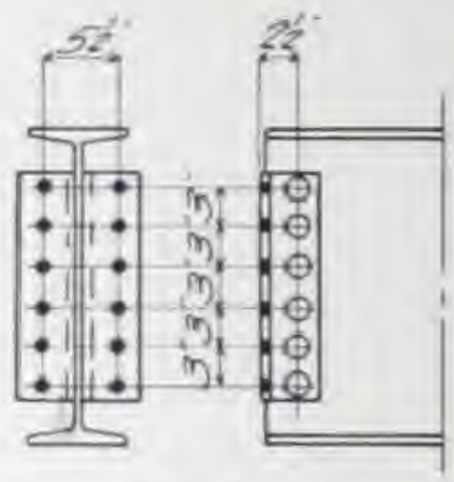
STANDARD BEAM CONNECTIONS

27-INCH



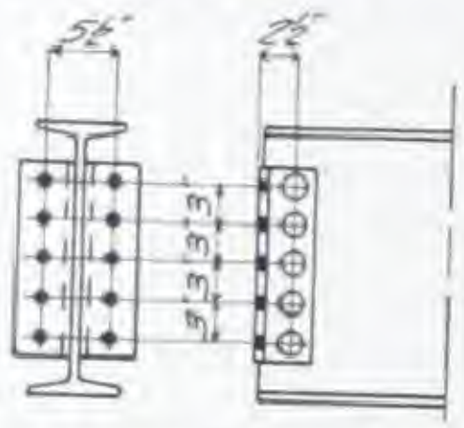
2 Angles 4" x 4" x ½" x 1'-8½"
Weight 46 lbs.

24-INCH



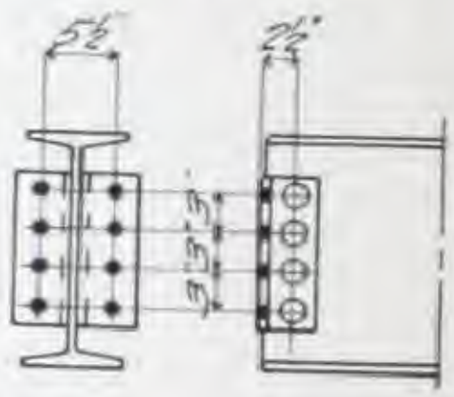
2 Angles 4" x 4" x ⅜" x 1'-5½"
Weight 30 lbs.

21- and 20-INCH



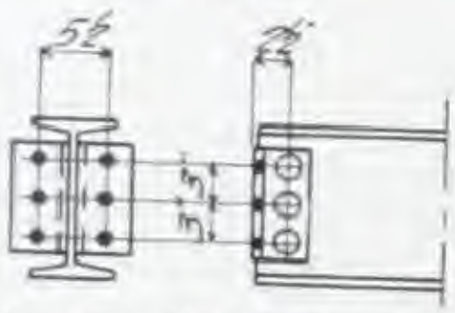
2 Angles 4" x 4" x ⅜" x 1'-2½"
Weight 25 lbs.

18- and 15-INCH



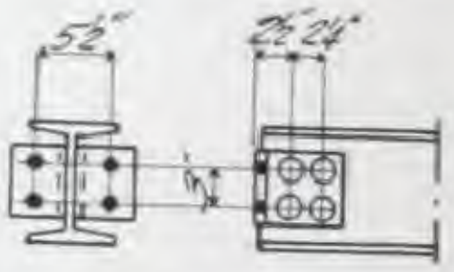
2 Angles 4" x 4" x ⅜" x 0'-11½"
Weight 20 lbs.

12-INCH



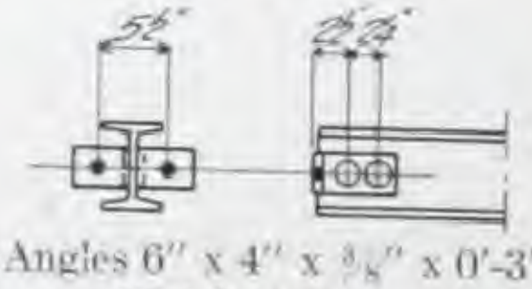
2 Angles 4" x 4" x ⅜" x 0'-8½"
Weight 15 lbs.

10-, 9- and 8-INCH



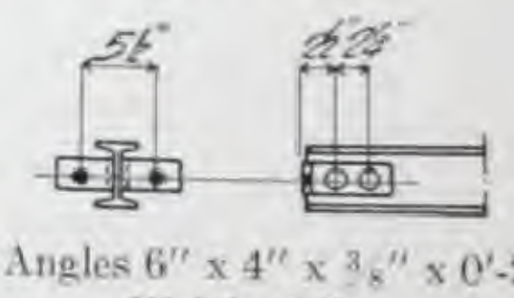
2 Angles 6" x 4" x ⅜" x 0'-5½"
Weight 13 lbs.

7-, 6- and 5-INCH



2 Angles 6" x 4" x ⅜" x 0'-3"
Weight 7 lbs.

4- and 3-Inch



2 Angles 6" x 4" x ⅜" x 0'-2"
Weight 5 lbs.

Rivets and bolts ¾" diameter.

Weights given are for ¾-inch shop rivets and angle connections; about 20 per cent should be added for field rivets or bolts.

LIMITING VALUES OF CONNECTIONS

FOR UNIFORMLY LOADED BEAMS

I-Beam		Strength of Web Connection with ¾" Shop Rivets.		Strength of Outstanding Legs of Connection Angles with ¾" Field Rivets	Minimum Span of Beam in feet.	"t" in inches
Depth in inches	Weight in lbs. per foot	Bearing in lbs.	Double Shear in lbs.	Single Shear in lbs.		
24	100.	.....	63,600	53,040	19.9	5/8
..	79.9	56,250	.....	53,040	17.5	5/8
20	81.4	.....	42,400	35,360	22.1	5/8
..	65.4	37,500	.....	35,360	17.6	5/8
18	70.	.....	42,400	35,360	15.5	5/8
..	54.7	34,500	.....	35,360	13.7	5/8
15	81.3	.....	42,400	35,360	16.0	5/8
..	42.9	30,750	.....	35,360	10.2	3/8
12	55.	.....	31,800	26,520	10.8	9/16
..	31.8	19,665	.....	26,520	9.8	7/16
10	40.	.....	42,400	17,680	9.6	5/8
..	25.4	23,250	.....	17,680	7.4	5/8
9	35.	.....	42,400	17,680	7.5	5/8
..	21.8	21,750	.....	17,680	5.7	5/8
8	25.5	40,575	.....	17,680	5.2	5/8
..	18.4	20,250	.....	17,680	4.3	5/8
7	15.3	9,415	.....	8,840	6.3	5/8
6	12.5	8,665	.....	8,840	4.5	5/8
5	10.	7,915	.....	8,840	3.2	9/16
4	7.7	7,125	.....	8,840	2.2	1/2
3	5.7	6,375	.....	8,840	1.4	7/16

t = web thickness, for bearing if beams frame opposite, to develop strength of connection angles.

ALLOWABLE UNIT STRESSES IN POUNDS PER SQUARE INCH:

Single Shear

Shop rivets—12,000 Field rivets—10,000

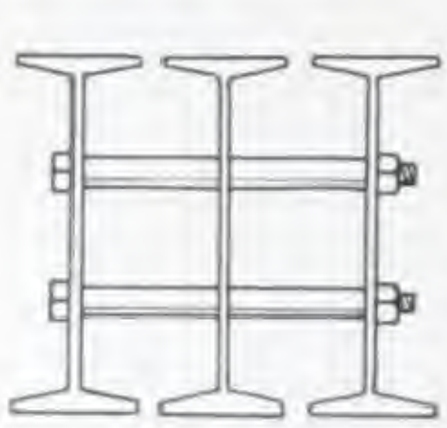
Bearing

Shop rivets—25,000 Field rivets—20,000

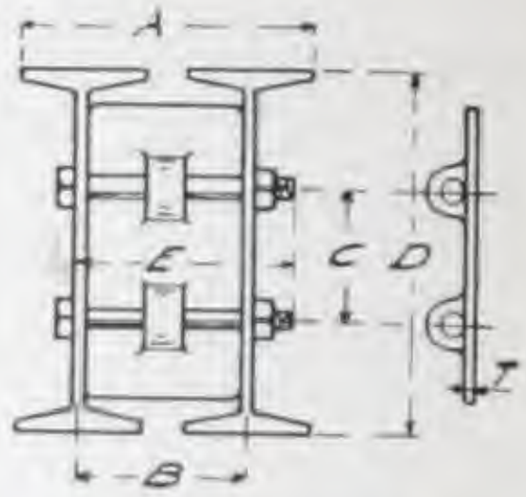
BEAM SEPARATORS

Beam separators may be cast iron separators, pipe separators, or sometimes steel channels.

Pipe separators are used in many cases owing to their convenience of adjustment to any necessary size. Channels are limited in use, owing to the fact that they are obtainable only in exact inch sizes. Specifications for cast iron separators are given in the table below.



No. 11—Compound Beam with Pipe Separators



No. 12—Compound Beam with Cast Iron Separator

SPECIFICATIONS FOR CAST IRON SEPARATORS

	BEAMS				SEPS.		BOLTS		
	D In.	Weight, Ft., Lbs	A In.	B In.	T In.	Weight, Lbs.	C In.	E In.	Wt., Polts & Nuts, Lbs.
ONE-BOLT SEPARATORS	3	5.7	$5\frac{5}{16}$	3	$\frac{3}{8}$	1.1	...	4	.95
	4	7.7	$5\frac{7}{8}$	$3\frac{1}{4}$	$\frac{3}{8}$	1.6	...	$4\frac{1}{2}$	1.01
	5	10.0	$6\frac{1}{2}$	$3\frac{1}{2}$	$\frac{3}{8}$	2.0	...	$4\frac{3}{4}$	1.04
	6	12.5	$7\frac{1}{16}$	4	$\frac{1}{2}$	3.3	...	$5\frac{1}{4}$	1.11
	7	15.3	$7\frac{7}{8}$	$4\frac{1}{4}$	$\frac{1}{2}$	3.9	...	$5\frac{1}{2}$	1.14
	8	18.4	$8\frac{1}{2}$	$4\frac{1}{2}$	$\frac{1}{2}$	4.7	...	$5\frac{3}{4}$	1.17
	9	21.8	$9\frac{1}{16}$	5	$\frac{1}{2}$	5.9	...	$6\frac{1}{4}$	1.23
	10	25.4	$9\frac{7}{8}$	$5\frac{1}{4}$	$\frac{1}{2}$	6.8	...	$6\frac{1}{2}$	1.26
	12	31.8	$10\frac{3}{4}$	$5\frac{3}{4}$	$\frac{1}{2}$	8.8	...	7	1.32
	12	40.8	$11\frac{3}{4}$	6	$\frac{1}{2}$	8.9	...	$7\frac{1}{2}$	1.38
TWO-BOLT SEPARATORS	12	31.8	$10\frac{3}{4}$	$5\frac{3}{4}$	$\frac{1}{2}$	9.5	$6\frac{1}{2}$	7	2.64
	12	40.8	$11\frac{3}{4}$	6	$\frac{1}{2}$	9.5	$6\frac{1}{2}$	$7\frac{1}{2}$	2.76
	15	42.9	$11\frac{3}{4}$	$6\frac{1}{4}$	$\frac{1}{2}$	12.5	7	$7\frac{3}{4}$	2.82
	15	60.8	$12\frac{3}{4}$	$6\frac{3}{4}$	$\frac{1}{2}$	13.0	7	$8\frac{1}{4}$	2.95
	15	65	$13\frac{1}{8}$	$7\frac{1}{4}$	$\frac{1}{2}$	13.2	7	9	3.13
	18	54.7	$12\frac{3}{4}$	$6\frac{3}{4}$	$\frac{5}{8}$	19.8	9	$8\frac{1}{4}$	2.95
	20	65.4	$13\frac{1}{4}$	7	$\frac{5}{8}$	22.9	10	$8\frac{1}{2}$	3.01
	20	81.4	$14\frac{3}{4}$	$7\frac{3}{4}$	$\frac{5}{8}$	24.6	10	$9\frac{1}{4}$	3.19
	24	79.9	$14\frac{3}{4}$	$7\frac{3}{4}$	$\frac{5}{8}$	30.3	12	$9\frac{1}{4}$	3.19

Dimensions given in above table refer to cut No. 12. Square head bolts, $\frac{3}{4}$-inch diameter, with nuts are used. Lengths and weights of separator bolts in above table are for girders composed of two beams of minimum section as shown.

STEEL BEARING PLATES

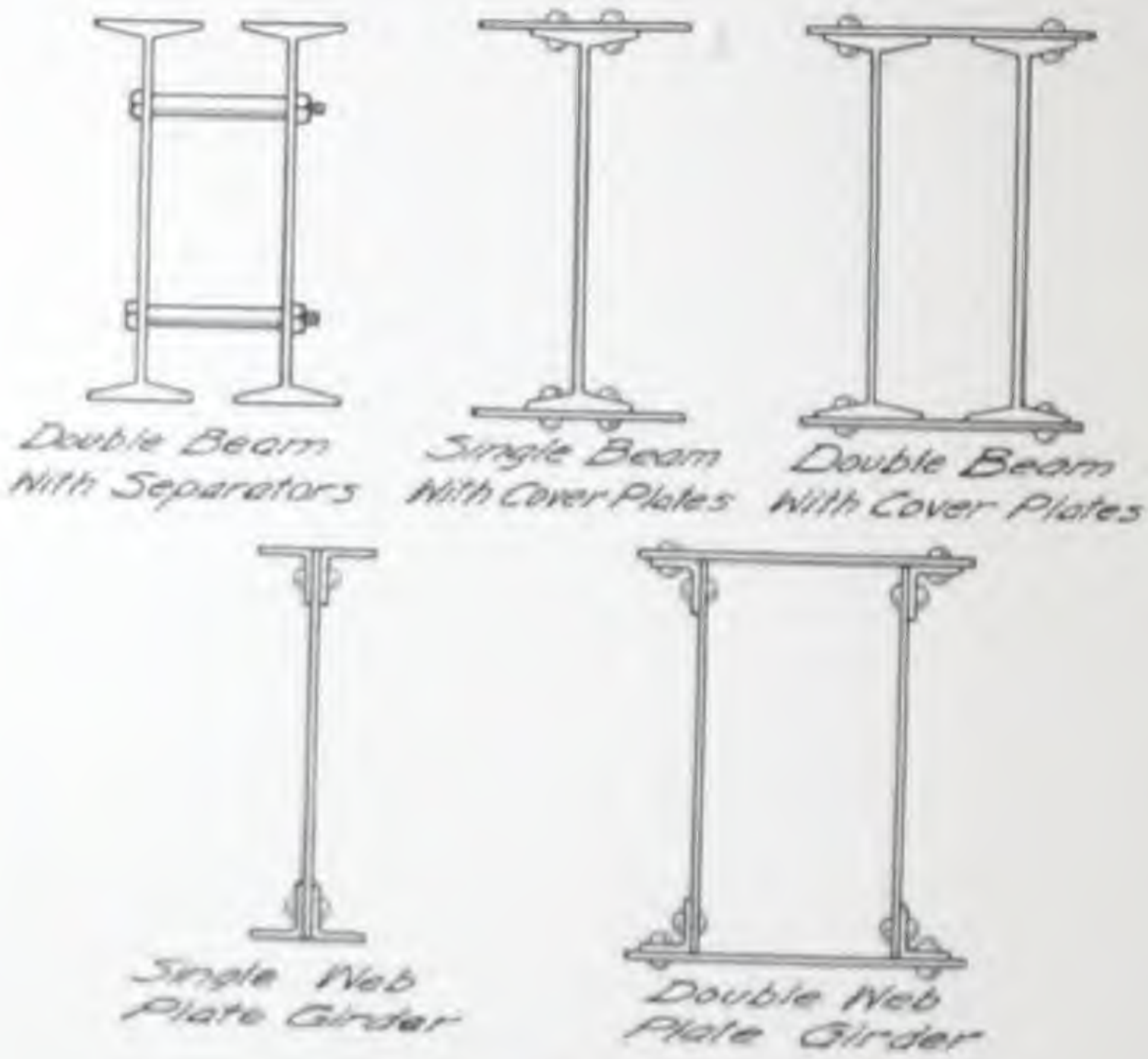
BEAM		Wall Bearing, Inches	Size in inches	Weight in Pounds	Common brick with lime mortar. 100 lbs. per sq. in. bearing pressure		Hard common select-brick, mortar 1 part Portland cement, 1 lime, 3 torpedo sand. 175 lbs. per sq. in. bearing pressure.		Portland cement concrete 1-2-4 mix. Machine mixed. 400 lbs. per sq. in. bearing pressure.		Common Size C. I. Bearing Plates	
Depth, In.	Wt., Lbs., per Ft.				Safe Load in 1000 lbs. on one Plate	Limiting Span in feet and inches	Safe Load in 1000 lbs. on one Plate	Limiting Span in feet and inches	Safe Load in 1000 lbs. on one Plate	Limiting Span in feet and inches	Size in inches	Weight including 2 per cent for overweight
24	79.9	16	16x16x1	73	25.6	36′ 0″	44.8	20′ 9″	67.3	13′ 6″	16x16x2	136
20	65.4	16	16x16x1	73	25.6	24′ 6″	44.8	14′ 0′	60.5	10′ 3″	16x16x1¾	119
18	54.7	16	16x16x1	73	25.6	18′ 6″	44.8	10′ 6″	54.8	8′ 6″	16x16x1¾	119
15	42.9	12	12x16x¾	41	19.2	16′ 0″	20.9	15′ 0″	20.9	15′ 0″	12x16x1¼	64
12	31.8	12	12x12x¾	31	14.4	13′ 3″	25.2	7′ 6″	35.3	5′ 3″	12x12x1¼	48
10	25.4	8	8x12x⅝	17	9.6	13′ 6″	14.9	8′ 9″	14.9	8′ 9″	8x12x1	25
9	21.8	8	8x12x⅝	17	9.6	10′ 6″	13.6	7′ 6″	13.6	7′ 6″	8x12x1	25
8	18.4	8	8x8x⅝	12	6.4	11′ 9″	11.2	6′ 9″	25.6	3′ 0″	8x8x1	17
7	15.3	8	8x8x⅝	12	6.4	8′ 9″	11.2	4′ 9″	25.6	3′ 0″	8x8x1	17
6	12.5	6	6x6x½	5	3.6	10′ 9″	6.3	6′ 3″	14.4	2′ 0″	6x6x¾	7
5	10	6	6x6x½	5	3.6	7′ 0″	6.3	4′ 0″	14.4	2′ 0″	6x6x¾	7

BEAM AND PLATE AND ANGLE GIRDERS

Where single rolled beams are insufficient to carry the loads, the required capacity may be obtained by various methods.

Two beams, connected with bolts and cast iron separators, or, for greater rigidity, with riveted plate and angle separators, can be used. The total strength of these is twice that of the single beam provided that the loads are applied equally on the two sections, otherwise their strength must be computed separately.

Single beam girders with plates riveted on top and bottom are often more economical than two beams connected with separators.



No. 13 — Typical Girder Sections

Box girders formed of two beams with plates riveted across the beam flanges are frequently used for supporting interior walls in buildings, but they are not as economical as single beams with flange plates or as plate girders. Box girders should not be used in exposed places, as their interior surfaces do not admit of repainting.

The most economical section is the single web plate girder; if not of sufficient strength, two single web plate girders may be used, with tie plates extending across the angles, or box girders may be made of four flange angles, two web plates and top and bottom flange plates. If the loads are not equally distributed, the two half-girders must be figured as separate units.

In the design of beams or plate girders the web must be of sufficient thickness to resist buckling stress or angle stiffeners must be provided. We will be pleased to supply designs for riveted girders to take any specified loading.

FOUNDATIONS

Foundation Loads.—Footings should be so designed that the loads they sustain per unit of area shall be as nearly uniform as possible, and the dead loads carried by the footings should include the actual weight of the superstructure and foundations down to the bottom of the footing. The live load should be assumed to be the same as the live load in the lowest tier of columns or in the footings under walls. The area of the footing is determined by dividing the total load by the unit resistance of the soil. From the area thus calculated all the other footings of the building are proportioned according to the ratios of their respective dead loads only. In no case should the load per square foot under any portion of any footing due to the combined dead, live and wind loads, exceed the safe sustaining power of the soil upon which the footing rests.

Bearing Power of Soils.—The bearing power of a soil depends upon the character of the soil, its freedom from water, and its lateral support. The downward pressure of the surrounding soil prevents lateral displacement of the material under the foundation and adds materially to the bearing power of treacherous soils.

The allowable pressures given in the table below may be used as an aid to the judgment in determining on a safe load for a foundation. However, no important foundations should be built without making careful soundings and bearing tests.

A soil incapable of supporting the required loads may have its supporting power increased (1) by increasing the depth of the foundation; (2) by draining the site; (3) by compacting the soil; (4) by adding a layer of sand or gravel; (5) by using grillages to increase the bearing area; (6) by driving piles through the soft stratum, or far enough into it to support the loads.

When foundations are placed on sand, gravel or clay, it is usually only necessary to dig a trench and start the foundation below frost. If the soil is somewhat yielding or if the load is heavy, the foundation should be carried to a greater depth, or the footing should be made wider than for greater depths.

The placing of three or four reinforcing rods continuous around wall footings is advantageous as it prevents the common cracking in foundation walls due to unequal settlement caused by the fact that soil is not uniform in any area.

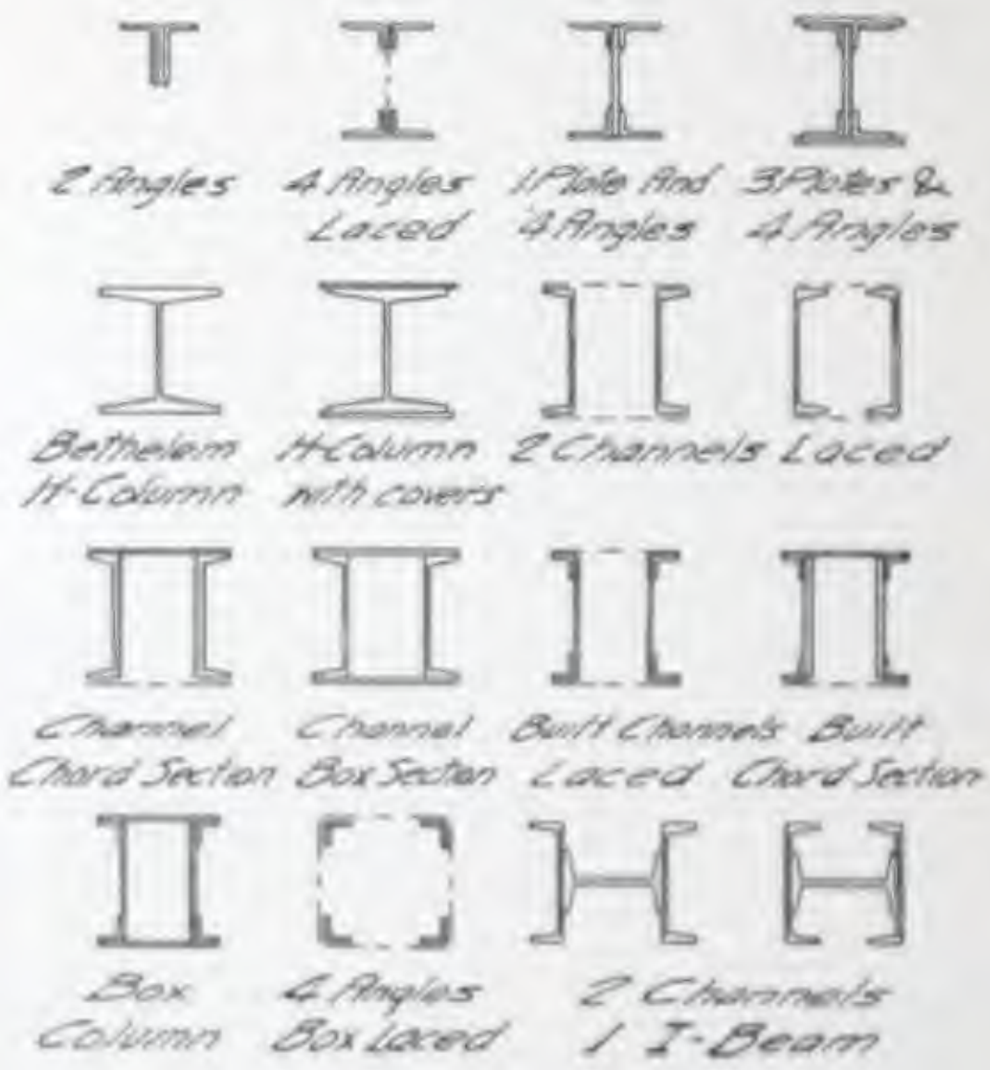
Allowable Foundation Pressures.—The following unit pressures for foundations have been proposed by Schneider in "Structural Design of Buildings":

Maximum Foundation Pressures

Kind of Material	Tons per Square Foot
Alluvial Soils	.5
Soft clay	1
Ordinary clay and dry sand mixed with clay	2
Dry sand and dry clay	3
Hard clay and firm, coarse sand	4
Firm, coarse sand and gravel	6
Rock	5 to 200

STEEL COLUMNS

Form and Size of Section.—Important as it may be to have the metal of the column section distributed as far as possible from the neutral axis, that is with as large a radius of gyration as possible, considerations of ease in fabrication and simplicity in connections are of greater weight. The economical column section is not that which affords the least weight of metal in the shaft, but that which, with a reasonable radius of gyration, provides the least weight of member, shaft and details with the minimum amount of riveting. Modern practice therefore, eliminates earlier forms of construction which represented the minimum amount of metal for the maximum radius of gyration, such, for example, as the column composed of three I-beams or one I-beam and two channels placed either with the flanges in or the flanges out. The Z-bar column has also fallen into disuse likewise a number of patented sections. The column sections should be of such size as to permit ready framing of beams and girders thereto and so



No. 14—Common Forms of Cross Section for Steel Columns and Struts.

placed in the construction as to permit the simplest details. Experience indicates that eight inches is the smallest desirable dimension in ordinary building work. For struts and light loads, smaller angle columns are still in use, while H-beams are excellent for such purposes. I-beams and single angles may be used with economy where the conditions of lengths and loading permit.

Design.—Column loads to be calculated in the design of ordinary columns for buildings are dead loads, including snow loads, and live loads. There are other loads such as impact, wind load *etc*., which are for particular cases and need not be considered here. The dead load is the load produced by the weight of floors, curtain walls, roof, steel *etc*., and can be accurately calculated. The live load depends on the use of which the building is to be put, and includes the weight of persons, furniture, goods and equipment. In determining the loads due to occupancy of stores and office buildings considerable judgement must be exercised. Since it is very improbable that the full live load will be imposed on all floors simultaneously, the loads used in calculating the strength of floor beams may be reduced for the calculation of column stresses.

For columns carrying more than five floors, live loads may be reduced as follows.

For roof and top floor, no reduction.

For each succeeding floor a reduction of 5% until 50% is reached, which load shall be used for all succeeding floors. This reduction does not apply for warehouses, which are likely to be loaded on all floors simultaneously.

Radius of Gyration.—As the strength of a column depends on its ability to resist flexural stress, the moment of inertia of its cross section is an important factor in the determination of its carrying capacity. For the purpose of computation, however, it is much more convenient to use the radius of gyration which depends on the moment of inertia.

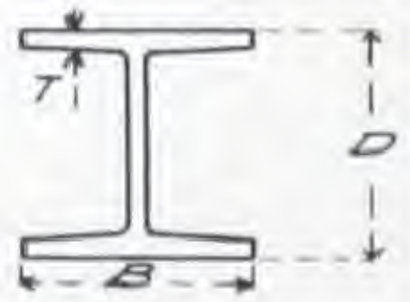
Ratio of Slenderness.—The ratio of slenderness is ratio of the unsupported length of a compression member to its radius of gyration, generally the least radius existing when the unsupported length of a column is equally braced in such a manner as to prevent deflection of the column in the direction which corresponds to the least radius of gyration. Columns, excepting those of square or circular section, have two principal radii of gyration. It is, therefore, necessary to determine the radii of gyration of such columns and to use the proper ratio of slenderness in any particular case. The unsupported length of a compression member should never exceed 200 times its least radius of gyration. The following are generally recognized as the upper limits of the value of $\frac{l}{r}$ where l = unsupported length in inches and r = least radius of gyration.

For lateral struts carrying wind stresses only, in buildings	150 to 200
For lateral struts carrying wind stresses only, in bridges	120 to 150
For columns in buildings with moment loads	120 to 150
For compression members in bridges	100 to 120

Explanation of Tables.—The tables which immediately follow give the safe loads in thousands of pounds on H-beam columns which, in the light of experience, are most desirable for use in ordinary building construction. In addition to the safe loads, they give least radii of gyration areas of sections, and weights in pounds per foot. For safe loads on I-beam columns and Carnegie H-sections, see page 9. For Bethlehem sections see pages 50 to 53.

Combined Bending and Compression Stresses.—It is assumed in the tables that the loads are direct and equally distributed over the cross section of the column or balanced on opposite sides thereof. In the case of beams carried on brackets or other forms of eccentric loading, bending stresses are produced which should be taken into consideration and the column sections so proportioned that the combined fiber stresses do not exceed the allowable axial compressive stresses.

SAFE LOADS, IN TONS OF 2000 LBS., FOR
BETHLEHEM ROLLED STEEL
8 In. H COLUMNS—SQUARE ENDS



Allowable stress per square inch:
13,000 lbs. for lengths under 55 radii. 16,000—55-l/r for lengths over 55 radii.

Weight of Section, Lbs. per Foot	Dimensions, Inches D	T	B	Area of Section, Square Inches	Least Radius of Gyration, Inches	UNSUPPORTED LENGTH OF COLUMNS 8 Ft.	9 Ft.	10 Ft.	11 Ft.	12 Ft.	13 Ft.	14 Ft.	15 Ft.	16 Ft.	17 Ft.	18 Ft.	20 Ft.	22 Ft.	24 Ft.	26 Ft.	Weight of Section, Lbs. per Foot
32.0	7 7/8	5/16	8.00	9.17	1.98	59.7	59.7	58.1	56.5	55.0	53.5	52.0	50.4	48.9	47.4	45.9	42.8	**39.7**	**36.7**		32.0
34.5	8	1/2	8.00	10.17	2.01	66.1	66.1	64.7	63.0	61.3	59.7	58.0	56.3	54.6	53.0	51.3	48.0	**44.6**	**41.3**	**38.0**	34.5
39.0	8 1/8	5/8	8.04	11.50	2.03	74.8	74.8	73.3	71.4	69.6	67.7	65.8	64.0	62.1	60.2	58.4	54.6	**50.9**	**47.1**	**43.4**	39.0
43.5	8 1/4	5/8	8.08	12.83	2.04	83.4	83.4	81.9	79.8	77.7	75.7	73.6	71.5	69.4	67.4	65.3	61.1	**57.0**	**52.8**	**48.7**	43.5
48.0	8 3/8	11/16	8.12	14.18	2.05	92.2	92.2	90.6	88.3	86.1	83.8	81.5	79.2	76.9	74.6	72.4	67.8	**63.2**	**58.7**	**54.1**	48.0
53.0	8 1/2	3/4	8.16	15.53	2.07	101.0	101.0	99.5	97.0	94.5	92.1	89.6	87.1	84.6	82.2	79.7	74.7	**69.8**	**64.8**	**59.9**	53.0
57.5	8 5/8	11/16	8.20	16.90	2.08	109.9	109.9	108.4	105.7	103.0	100.3	97.7	95.0	92.3	89.6	86.9	81.6	**76.2**	**70.9**	**65.5**	57.5
62.0	8 3/4	7/8	8.24	18.27	2.09	118.8	118.8	117.3	114.4	111.5	108.7	105.8	102.9	100.0	97.1	94.2	88.5	**82.7**	**76.9**	**71.2**	62.0
67.0	8 7/8	11/16	8.28	19.66	2.11	127.8	127.8	126.5	123.5	120.4	117.3	114.2	111.2	108.1	105.0	101.9	95.8	89.6	**83.5**	**77.3**	67.0
71.5	9	1	8.32	21.05	2.12	136.8	136.8	135.6	132.4	129.1	125.8	122.5	119.2	116.0	112.7	109.4	102.9	96.3	**89.8**	**83.2**	71.5
76.5	9 1/8	1 1/16	8.36	22.46	2.13	146.0	146.0	144.9	141.4	137.9	134.4	131.0	127.5	124.0	120.5	117.0	110.1	103.1	**96.2**	**89.2**	76.5
81.0	9 1/4	1 1/8	8.39	23.78	2.14	154.6	154.6	153.6	149.9	146.2	142.6	138.9	135.2	131.6	127.9	124.2	116.9	109.6	**102.2**	**94.9**	81.0
85.5	9 3/8	1 3/16	8.43	25.20	2.16	163.8	163.8	163.1	159.3	155.4	151.6	147.7	143.9	140.0	136.1	132.3	124.6	116.9	**109.2**	**101.5**	85.5
90.5	9 1/2	1 1/4	8.47	26.64	2.17	173.2	173.2	172.6	168.6	164.5	160.5	156.4	152.4	148.3	144.3	140.2	132.1	124.0	**115.9**	**107.8**	90.5

Loads in "light" type are for lengths less than 125 radii; loads in "**heavy**" type are for lengths greater than 125 radii.

For loads on Carnegie 4" to 8" H columns, see page 9.

SAFE LOADS, IN TONS OF 2000 LBS., FOR
BETHLEHEM ROLLED STEEL
10 In. H-COLUMNS—SQUARE ENDS

For loads on Cantilevers 4" to 8" H sections, see page 31.

SAFE LOADS, IN TONS OF 2000 LBS., FOR
BETHLEHEM ROLLED STEEL
12 In. H-COLUMNS SQUARE ENDS

Allowable stress per square inch

(1,000 lbs. for lengths under 50 radii) (16,000 - 60x l/r for lengths over 50 radii)

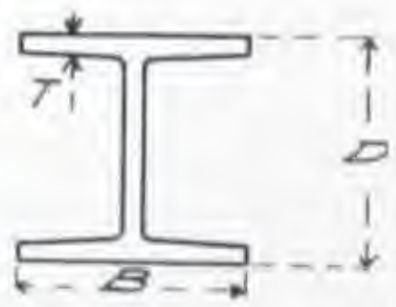
Weight per Foot	Dimensions Inches			Area of Section Square Inches	Least Radius of Gyration Inches	UNSUPPORTED LENGTH OF COLUMNS															Weight per Foot
	B	T	K			10 ft.	11 ft.	12 ft.	13 ft.	14 ft.	15 ft.	16 ft.	17 ft.	18 ft.	19 ft.	20 ft.	21 ft.	22 ft.	23 ft.	24 ft.	
53.0	8	1	1	15.59	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	53.0
49.0	8	1/2	1	14.42	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	49.0
46.0	8	1/2	1	13.53	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	46.0
42.0	8	1/2	1	12.36	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	42.0
40.0	8	1/2	1	11.77	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	40.0
38.0	8	1/2	1	11.18	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	38.0
36.0	8	1/2	1	10.59	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	36.0
34.0	8	1/2	1	10.00	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	34.0
32.0	8	1/2	1	9.41	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	32.0
31.0	8	1/2	1	9.12	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	31.0
28.0	8	1/2	1	8.24	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	28.0
26.0	8	1/2	1	7.65	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	26.0
24.0	8	1/2	1	7.06	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	24.0
23.0	8	1/2	1	6.77	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	23.0
22.0	8	1/2	1	6.47	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	22.0
21.0	8	1/2	1	6.18	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	21.0
20.0	8	1/2	1	5.89	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	20.0
19.0	8	1/2	1	5.59	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	19.0
18.0	8	1/2	1	5.30	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	18.0
17.0	8	1/2	1	5.01	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	17.0
16.0	8	1/2	1	4.71	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	16.0
15.0	8	1/2	1	4.42	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	15.0
14.0	8	1/2	1	4.13	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	14.0
13.0	8	1/2	1	3.83	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	13.0
12.0	8	1/2	1	3.54	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	12.0
53.0	8	1/2	1	15.59	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	53.0
49.0	8	1/2	1	14.42	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	49.0
46.0	8	1/2	1	13.53	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	46.0
42.0	8	1/2	1	12.36	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	42.0
40.0	8	1/2	1	11.77	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	40.0
38.0	8	1/2	1	11.18	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	38.0
36.0	8	1/2	1	10.59	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	36.0
34.0	8	1/2	1	10.00	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	34.0
32.0	8	1/2	1	9.41	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	32.0
31.0	8	1/2	1	9.12	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	31.0
28.0	8	1/2	1	8.24	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	28.0
26.0	8	1/2	1	7.65	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	26.0
24.0	8	1/2	1	7.06	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	24.0
23.0	8	1/2	1	6.77	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	23.0
22.0	8	1/2	1	6.47	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	22.0
21.0	8	1/2	1	6.18	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	21.0
20.0	8	1/2	1	5.89	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	20.0
19.0	8	1/2	1	5.59	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	19.0
18.0	8	1/2	1	5.30	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	18.0
17.0	8	1/2	1	5.01	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	17.0
16.0	8	1/2	1	4.71	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	16.0
15.0	8	1/2	1	4.42	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	15.0
14.0	8	1/2	1	4.13	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	14.0
13.0	8	1/2	1	3.83	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	13.0
12.0	8	1/2	1	3.54	1.82	2	50	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.3	44.7	44.1	43.5	42.9	42.3	12.0

Loads in "light" type are for lengths less than 50 radii. Loads in "heavy" type are for lengths greater than 120 radii.

SAFE LOADS, IN TONS OF 2000 LBS., FOR

BETHLEHEM ROLLED STEEL
12 In. H-COLUMNS—SQUARE ENDS

Allowable stress per square inch:
13,000 lbs. for lengths under 55 radii. 16,000—55-l/r for lengths over 55 radii.



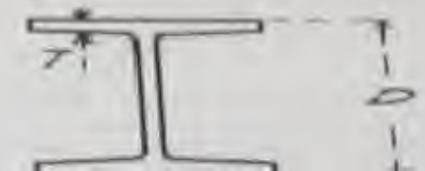
Weight of Section, Lbs. per Foot.	Dimensions, Inches D	T	B	Area of Section, Square Inches.	Least Radius of Gyration, Inches.	UNSUPPORTED LENGTH OF COLUMNS 12 Ft.	12 Ft.	14 Ft.	16 Ft.	18 Ft.	20 Ft.	22 Ft.	24 Ft.	26 Ft.	28 Ft.	30 Ft.	32 Ft.	34 Ft.	36 Ft.	38 Ft.	Weight of Section, Lbs. per Foot.
64.5	11¾	5/8	11.92	19.00	2.98	123.5	123.5	122.5	118.3	114.1	109.9	105.7	101.5	97.3	93.1	88.9	**84.7**	**80.5**	**76.3**	.....	64.5
71.5	11⅞	11/16	11.96	20.96	3.00	136.2	136.2	135.4	130.8	126.2	121.6	117.0	112.4	107.8	103.1	98.5	**93.9**	**89.3**	**84.7**	.....	71.5
78.0	12	¾	12.00	22.94	3.01	149.1	149.1	148.3	143.3	138.3	133.2	128.2	123.2	118.1	113.1	108.1	**103.0**	**98.0**	**93.0**	.....	78.0
84.5	12⅛	13/16	12.04	24.92	3.03	162.0	162.0	161.4	155.9	150.5	145.1	139.7	134.2	128.8	123.4	117.9	**112.5**	**107.1**	**101.7**	.....	84.5
91.5	12¼	⅞	12.08	26.92	3.04	175.0	175.0	174.5	168.6	162.8	156.9	151.1	145.2	139.4	133.5	127.7	**121.9**	**116.0**	**110.2**	**104.3**	91.5
98.5	12⅜	15/16	12.12	28.92	3.06	188.0	188.0	187.7	181.5	175.2	169.0	162.8	156.5	150.3	144.0	137.8	**131.6**	**125.3**	**119.1**	**112.8**	98.5
105.0	12½	1	12.16	30.94	3.07	201.1	201.1	201.0	194.3	187.7	181.0	174.4	167.7	161.1	154.4	147.8	**141.1**	**134.4**	**127.8**	**121.1**	105.0
112.0	12⅝	1 1/16	12.20	32.96	3.08	214.2	214.2	214.2	207.2	200.1	193.1	186.0	178.9	171.9	164.8	157.7	150.7	**143.6**	**136.6**	**129.5**	112.0
118.5	12¾	1⅛	12.23	34.87	3.10	226.7	226.7	226.7	219.6	212.1	204.7	197.3	189.9	182.5	175.0	167.6	160.2	**152.8**	**145.3**	**137.9**	118.5
125.5	12⅞	1 3/16	12.27	36.91	3.11	239.9	239.9	239.9	232.6	224.8	217.0	209.1	201.3	193.5	185.6	177.8	170.0	**162.1**	**154.3**	**146.5**	125.5
132.5	13	1¼	12.31	38.97	3.13	253.3	253.3	253.3	246.0	237.8	229.6	221.4	213.2	204.9	196.7	188.5	180.3	**172.1**	**163.9**	**155.6**	132.5
139.5	13⅛	1 5/16	12.35	41.03	3.14	266.7	266.7	266.7	259.3	250.6	242.0	233.4	224.8	216.1	207.5	198.9	190.3	**181.6**	**173.0**	**164.4**	139.5
146.5	13¼	1⅜	12.39	43.10	3.15	280.2	280.2	280.2	272.6	263.5	254.5	245.5	236.4	227.4	218.4	209.3	200.3	**191.3**	**182.3**	**173.2**	146.5
153.5	13⅜	1 7/16	12.43	45.19	3.16	293.7	293.7	293.7	286.0	276.6	267.1	257.7	248.3	238.8	229.4	219.9	210.5	**201.1**	**191.6**	**182.2**	153.5
161.0	13½	1½	12.47	47.28	3.18	307.3	307.3	307.3	299.7	289.9	280.1	270.3	260.5	250.7	240.9	231.0	221.2	**211.4**	**201.6**	**191.8**	161.0

Loads in "light" type are for lengths less than 125 radii; loads in **"heavy"** type are for lengths greater than 125 radii.

SAFE LOADS, IN TONS OF 2000 LBS., FOR

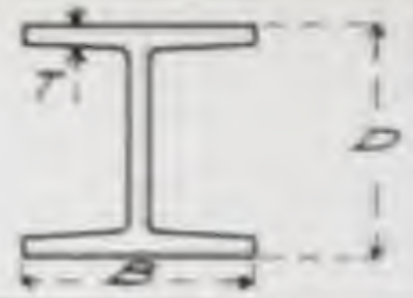
BETHLEHEM ROLLED STEEL
14 In. H-COLUMNS—SQUARE ENDS

Allowable stress per square inch:



SAFE LOADS, IN TONS OF 2000 LBS., FOR
BETHLEHEM ROLLED STEEL
14 In. H-COLUMNS—SQUARE ENDS

Allowable stress per square inch:
13,000 lbs. for lengths under 55 radii. 16,000—55 l/r for lengths over 55 radii.

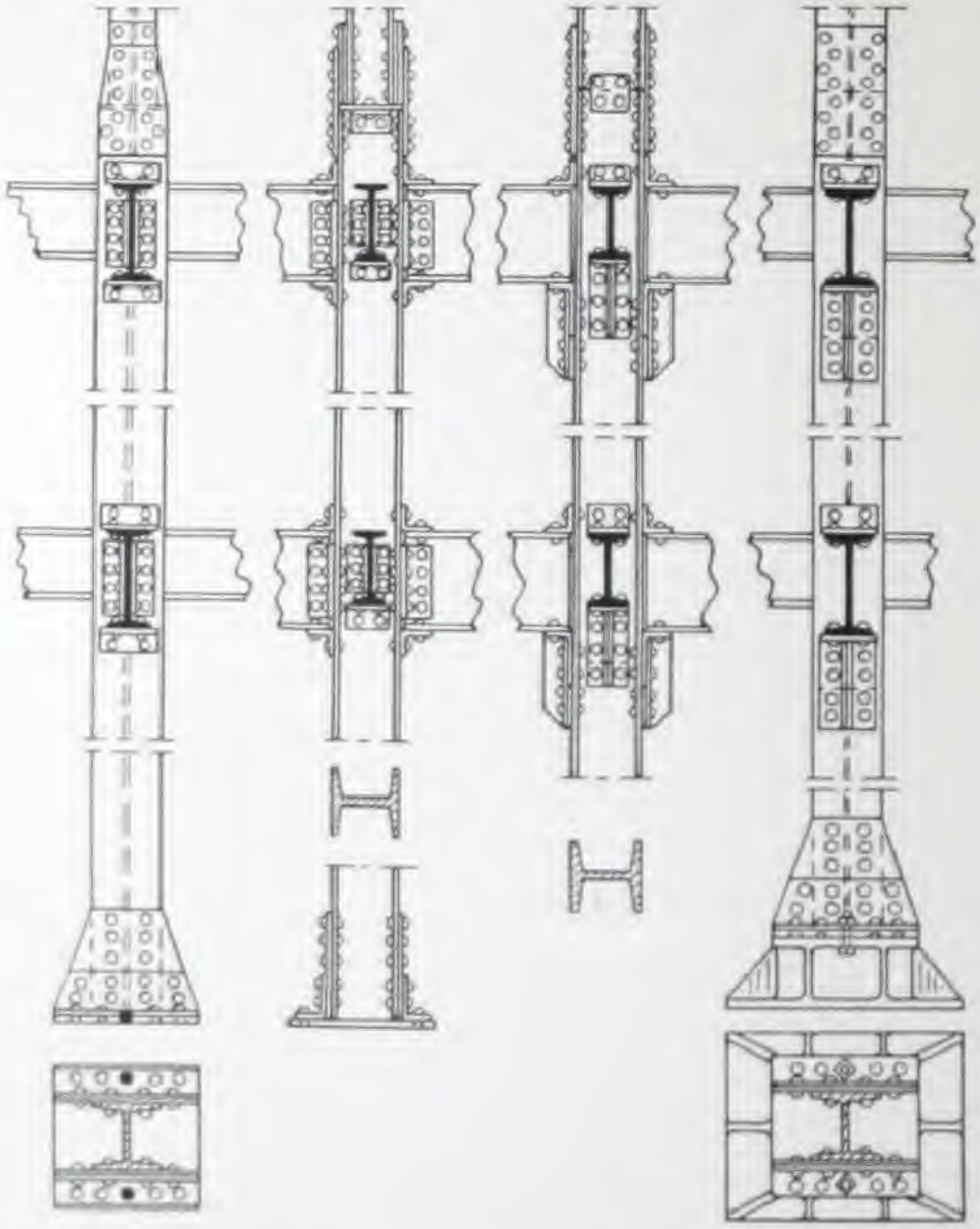


Weight of section, Lbs. per Foot	Dimensions, Ins. D	T	B	Area of section, Square Inches	Least radius of Gyration, Inches	UNSUPPORTED LENGTH OF COLUMNS 10 Ft.	12 Ft.	14 Ft.	16 Ft.	18 Ft.	20 Ft.	22 Ft.	24 Ft.	25 Ft.	28 Ft.	30 Ft.	32 Ft.	36 Ft.	40 Ft.	44 Ft.	Weight of Section, Lbs. per Foot
83.5	13¹⁵/₁₆	½	13.97	24.46	3.47	139.0	139.0	139.0	138.5	133.8	149.2	144.5	139.9	137.5	130.5	125.0	121.2	111.9	**102.6**		83.5
91.0	13¾	⅝	13.96	26.76	3.46	173.9	173.9	173.9	173.9	168.5	163.4	158.4	153.3	148.2	143.2	138.1	133.1	122.9	**112.8**		91.0
99.0	14	¾	14.03	29.06	3.50	189.0	188.9	188.9	188.9	183.2	177.7	172.2	166.7	163.2	155.8	150.3	144.8	133.8	**122.9**	**111.9**	99.0
106.5	14⅛	13/16	14.04	31.38	3.52	204.0	204.0	204.0	204.0	198.1	192.2	186.3	180.4	174.6	168.7	162.8	156.9	145.1	**133.4**	**121.6**	106.5
114.5	14¼	⅞	14.08	33.70	3.53	219.1	219.1	219.1	219.1	212.9	206.6	200.3	194.0	187.7	181.4	175.1	168.8	156.2	**143.6**	**131.0**	114.5
122.5	14⅜	1	14.12	36.04	3.55	234.3	234.3	234.3	234.3	228.0	221.5	214.9	207.9	201.2	194.5	187.8	181.1	167.7	**154.3**	**140.9**	122.5
130.5	14½	1⅛	14.19	38.38	3.56	249.5	249.5	249.5	249.5	243.0	236.9	228.8	221.7	214.5	207.4	200.3	193.2	179.0	**164.7**	**150.5**	130.5
138.0	14⅝	1¼	14.19	40.59	3.58	263.8	263.8	263.8	263.8	257.4	249.9	242.4	234.9	227.4	220.0	212.5	205.0	190.0	**175.1**	**160.1**	138.0
146.0	14¾	1⅜	14.23	42.95	3.59	278.2	279.2	279.2	279.2	272.5	264.6	256.7	248.9	241.0	233.1	225.2	217.3	201.5	**185.7**	**170.0**	146.0
154.0	14⅞	1⅜	14.27	45.33	3.61	294.7	294.7	294.7	294.7	288.1	279.8	271.5	263.2	254.9	246.6	238.3	230.0	213.5	**196.9**	**180.3**	154.0
162.0	15	1⅜	14.31	47.71	3.62	310.1	310.1	310.1	310.1	303.4	294.7	286.0	277.3	268.6	259.9	251.2	242.5	225.1	**207.7**	**190.3**	162.0
170.5	15⅛	1⅝	14.35	50.11	3.64	325.7	325.7	325.7	325.7	319.0	309.9	300.8	291.7	282.6	273.5	264.4	255.3	237.1	**218.9**	**200.7**	170.5
178.5	15¼	1¾	14.40	52.51	3.65	341.3	341.3	341.3	341.3	334.6	325.1	315.6	306.1	296.6	287.1	277.6	268.1	249.1	**230.1**	**211.1**	178.5
186.5	15⅜	1⅞	14.42	54.92	3.66	357.0	357.0	357.0	357.0	350.3	340.4	330.5	320.6	310.7	300.8	290.9	281.0	261.2	**241.4**	**221.6**	186.5
195.0	15½	1⅞	14.42	57.35	3.68	372.8	372.8	372.8	372.8	366.1	355.8	345.5	335.2	324.9	314.6	304.3	294.0	273.4	**252.8**	**232.2**	195.0
203.5	15⅝	1⅞	14.51	59.79	3.69	388.6	388.6	388.6	388.6	381.9	371.2	360.5	349.8	339.1	328.4	317.7	307.0	285.6	**264.2**	**242.8**	203.5
211.0	15¾	1¹⁵/₁₆	14.58	62.07	3.70	403.5	403.5	403.5	403.5	396.9	385.8	374.8	363.7	352.6	341.6	330.5	319.4	297.3	**275.1**	**253.0**	211.0
219.5	15⅞	1¹⁵/₁₆	14.58	64.52	3.71	419.4	419.4	419.4	419.4	412.9	401.5	390.0	378.5	367.1	355.6	344.1	332.6	309.7	**286.8**	**263.8**	219.5
227.5	16	1⅞	14.62	66.99	3.72	435.4	435.4	435.4	435.4	429.0	417.2	405.3	393.4	381.6	369.7	357.8	345.9	322.2	**298.5**	**274.8**	227.5
235.0	16⅛	1¹³/₁₆	14.66	69.45	3.74	451.4	451.4	451.4	451.4	445.2	433.0	420.7	408.4	396.2	383.9	371.6	359.4	334.8	**310.3**	**285.8**	235.0
244.5	16¼	1⅞	14.70	71.98	3.75	467.6	467.6	467.6	467.6	461.5	448.9	436.2	423.6	410.9	398.2	385.6	372.9	347.6	**322.2**	**296.9**	244.5
253.0	16⅜	2	14.78	74.43	3.76	483.9	483.9	483.9	483.9	477.9	464.8	451.8	438.7	425.7	412.6	399.6	386.5	360.4	**334.3**	**308.1**	253.0
261.5	16½	2⅛	14.78	76.93	3.77	500.0	500.0	500.0	500.0	494.4	480.9	467.4	454.0	440.5	427.1	413.6	400.2	373.3	**346.4**	**319.5**	261.5
270.0	16⅝	2⅛	14.82	79.44	3.79	516.4	516.4	516.4	516.4	510.9	497.0	483.2	469.3	455.5	441.6	427.8	413.9	386.3	**358.6**	**330.9**	270.0
278.5	16¾	2⅛	14.86	81.95	3.80	532.8	532.8	532.8	532.8	527.6	513.5	499.4	485.3	470.9	456.9	442.1	427.8	399.4	**370.9**	**342.4**	278.5
287.5	16⅞	2⅛	14.90	84.50	3.81	549.3	549.3	549.3	549.3	544.5	529.6	515.0	500.4	485.7	471.1	456.4	441.8	412.5	**383.3**	**354.0**	287.5

Loads in "light" type are for lengths less than 120 radii. Loads in "**heavy**" type are for lengths greater than 120 radii.

STEEL COLUMN DETAILS

Steel columns are usually made long enough to extend two stories in height in one section. At all joints splice plates should be provided connecting the two sections. The joints are faced and a good bearing insured, only sufficient splice being used to take care of the bending moment at the point and to hold the parts in position.



No. 15—Types of H-Column and Base Details

The use of column caps should be avoided if possible. The beams or trusses connecting to columns should generally be rivetted to the webs or flanges with connection angles and not set on the top of a cap plate. It is necessary to put a base on a column large enough to distribute the loads to the masonry footings. This base may be built up of rolled shapes and plates; or a cast iron or cast steel sub-base may be interposed between the column base proper and the masonry. In some cases a grillage of beams and concrete is used for distributing the load over the soil. This has its advantages as it eliminates deep excavation and large masses of concrete.

CAST IRON COLUMNS

Cast iron columns are suitable only for small buildings of non-fireproof construction. They offer greater resistance to fire than unprotected steel columns, and occupy a minimum of space in the building; but cast iron is not as reliable as steel and should not be used where there is eccentric loading.

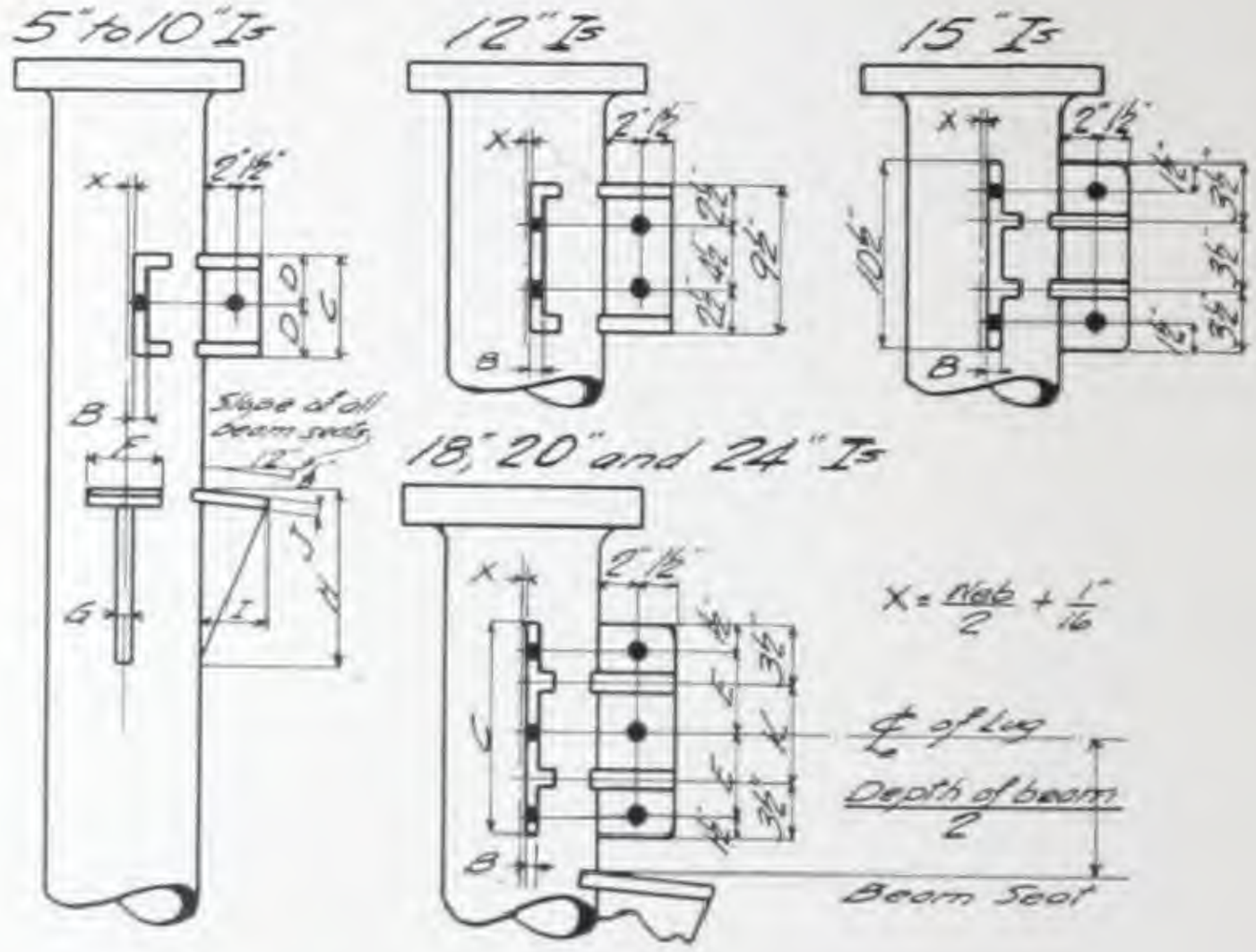
SAFE LOADS IN TONS OF 2,000 POUNDS FOR HOLLOW ROUND CAST IRON COLUMNS WITH SQUARE ENDS

Diam. In.	Thickness, In.	LENGTH OF COLUMN IN FEET										Area Metal, In.	Wt. per Foot of Length
		6	8	10	12	14	16	18	20	22	24		
5	¾	39	34	29	24							10.0	31.3
	⅞	45	38	32	27							11.3	35.3
5½	¾	46	40	35	30	26						11.2	35.0
	⅞	52	46	40	34	29						12.7	39.7
6	¾	52	47	41	36	31	27	24				12.4	38.7
	⅞	60	53	47	41	36	31	27				14.1	44.0
	1	66	59	52	45	39	34	30				15.7	49.0
7	¾	65	60	54	48	43	38	34				14.7	46.0
	⅞	74	68	62	55	49	43	38				16.8	52.6
	1	83	76	68	61	54	48	43				18.8	58.9
8	¾	78	72	67	61	55	50	45	40	36	33	17.1	53.4
	⅞	89	83	76	70	63	57	51	46	41	37	19.6	61.2
	1	100	93	86	79	71	64	58	52	47	42	22.0	68.7
9	⅞	103	98	91	85	80	71	65	59	54	49	22.3	69.8
	1	117	110	103	95	90	80	73	67	61	55	25.1	78.5
	1⅛	129	122	114	105	99	89	81	74	67	61	27.8	87.0
10	⅞	118	112	106	100	93	86	79	73	67	62	25.1	78.4
	1	133	127	120	112	105	97	89	82	76	69	28.3	88.4
	1⅛	147	141	133	125	116	107	99	91	84	77	31.4	98.0
	1¼	161	154	146	136	127	118	109	100	92	84	34.4	107.4
11	1	149	143	137	129	122	114	106	98	91	85	31.4	98.2
	1⅛	165	159	152	144	135	126	118	109	101	94	34.9	109.1
	1¼	182	175	167	158	148	139	129	120	111	103	38.3	119.7
	1⅜	197	190	181	171	161	151	140	130	121	112	41.6	129.9
12	1¼	184	178	171	163	154	146	137	128	120	112	38.4	120.1
	1¼	202	195	188	179	170	160	150	141	132	123	42.2	131.9
	1⅜	220	212	204	194	184	174	163	153	143	133	45.9	143.4
	1½	237	229	220	210	199	187	176	165	154	144	49.5	154.6

Cast Iron Column Bases—Cast iron column bases can be supplied to suit all sizes and loadings of columns. A large range of patterns are carried in stock.

CAST IRON COLUMN DETAILS

In the usual forms of connection of girders and beams to cast iron columns, the beam rests on the bracket-shelf, as shown in No. 16 below, and is bolted to the lug through the web. Connections should be designed with a bracket directly below the web of a single beam, or below both webs on a double beam. The bracket-shelf should be given a slope of $\frac{1}{8}$-inch to the foot away from the column so that the load cannot be applied at the edge of the shelf when the beam is deflected under its load.



No. 16—Standard Cast Iron Column Connections

DIMENSIONS FOR STANDARD CAST IRON COLUMN CONNECTIONS

Size Beam In.	B In.	C In.	D In.	E In.	F In.	G In.	H In.	I In.	J In.	K In.	Max. Load Lbs.	Weight Bracket Lbs.
5	$\frac{5}{8}$	3	$1\frac{1}{2}$	....	4	$\frac{3}{4}$	5	$3\frac{1}{2}$	$\frac{7}{8}$	....	9000	8.50
6	$\frac{5}{8}$	3	$1\frac{1}{2}$	....	$4\frac{1}{2}$	$\frac{7}{8}$	5	$3\frac{1}{2}$	1	....	9000	9.50
7	$\frac{5}{8}$	3	$1\frac{1}{2}$	....	$4\frac{1}{2}$	$\frac{7}{8}$	5	$3\frac{1}{2}$	1	....	9000	9.50
8	$\frac{3}{4}$	4	2	....	$4\frac{1}{2}$	1	6	4	1	....	12000	13.75
9	$\frac{3}{4}$	4	2	....	5	$1\frac{1}{8}$	$7\frac{1}{4}$	4	$1\frac{1}{4}$	....	17000	16.00
10	$\frac{3}{4}$	4	2	....	5	$1\frac{1}{8}$	$7\frac{1}{4}$	4	$1\frac{1}{4}$	....	17000	16.00
12	$\frac{3}{4}$	....	....	....	6	$1\frac{1}{8}$	$9\frac{1}{4}$	4	$1\frac{1}{4}$	....	23000	24.00
15	$\frac{7}{8}$	....	....	....	$6\frac{1}{2}$	$1\frac{1}{4}$	$10\frac{1}{4}$	4	$1\frac{1}{4}$	....	33000	29.00
18	1	12	....	$4\frac{1}{2}$	$6\frac{1}{2}$	$1\frac{1}{2}$	$10\frac{1}{2}$	4	$1\frac{1}{2}$	5	34000	37.00
20	1	13	....	5	7	$1\frac{1}{2}$	$11\frac{1}{2}$	4	$1\frac{1}{2}$	6	38000	40.50
24	1	15	....	6	$7\frac{1}{2}$	$1\frac{1}{2}$	$13\frac{1}{2}$	4	$1\frac{1}{2}$	8	45000	46.50

All holes cored for $\frac{3}{4}$-inch bolts.
Loads on brackets must not exceed loads shown in column marked maximum load.

STANDARD PIPE COLUMNS

Steel pipe columns are frequently used for light loads where the loads are quiescent and there is no probability of side thrust. The caps and bases of these are usually loose cast iron with a cross projection which fits inside the pipe. The pipes are machined; also the part of the base or cap where the pipe bears.

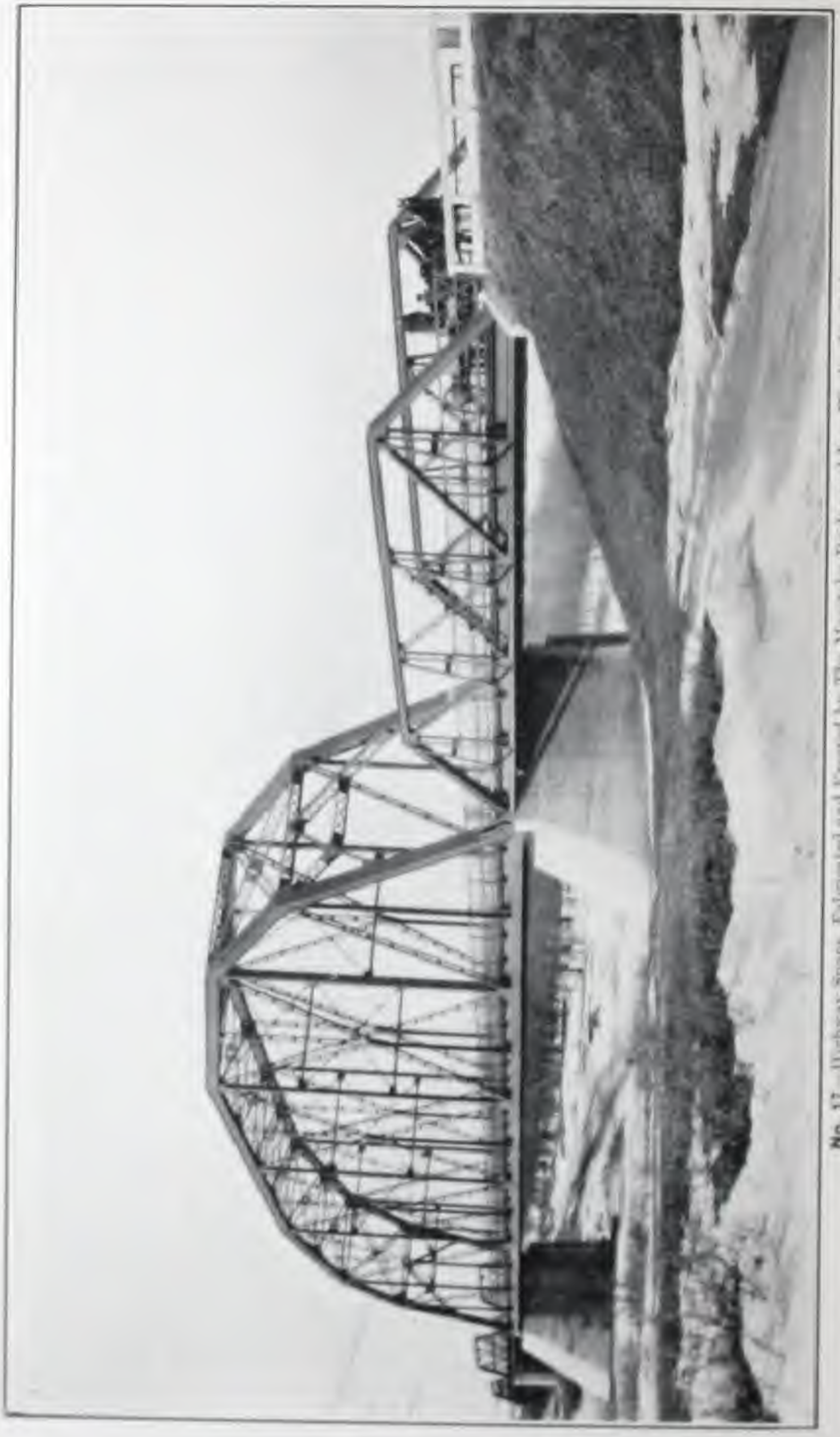
SAFE LOADS IN THOUSANDS OF POUNDS FOR STANDARD PIPE COLUMNS

Nominal Size, In.		15	14	13	12	11	10	9	8	7	6	5	4½	4	3½	3	2½	2	1½
External Dia. In.		16.000	15.000	14.000	12.750	11.750	10.750	9.625	8.625	7.625	6.625	5.563	5.000	4.500	4.000	3.500	2.875	2.375	1.900
Thickness, In.		.375	.475	.375	.375	.375	.365	.342	.322	.301	.280	.258	.247	.237	.226	.216	.203	.154	.145
Effective Length, Feet	5	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	55.9	48.0	41.2	34.8	29.0	**21.6**	**12.2**	**7.5**
	6	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	55.9	48.0	41.2	34.8	**28.6**	**19.4**	**10.6**	**6.0**
	7	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	55.9	48.0	41.2	**34.1**	**26.3**	**17.3**	**9.0**	5.0
	8	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	55.9	48.0	**40.1**	**31.7**	**24.0**	**15.1**	7.4	4.3
	9	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	55.9	**46.4**	**37.6**	**29.3**	**21.7**	**12.9**	6.6	3.8
	10	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	**54.2**	**43.8**	**35.1**	**26.9**	**19.4**	11.4	5.8	3.4
	11	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	**51.5**	**41.2**	**32.6**	**24.5**	**17.1**	10.3	5.3	3.0
	12	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	**70.2**	**48.7**	**38.5**	**30.0**	**22.1**	15.8	9.8	4.9	2.7
	13	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	**89.9**	**67.3**	**46.0**	**35.9**	**27.5**	**19.7**	14.0	8.1	4.5	2.5
	14	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	**86.7**	**64.3**	**43.2**	**33.3**	**25.0**	18.0	12.9	7.0		
	15	239.3	224.0	208.7	189.5	174.2	154.8	129.6	**108.1**	**83.5**	**61.3**	**40.5**	**30.6**	**22.5**	16.8	11.7	6.0		
	16	239.3	224.0	208.7	189.5	174.2	154.8	129.6	**104.7**	**80.3**	**58.3**	**37.7**	**28.0**	21.1	15.6	10.6			
	17	239.3	224.0	208.7	189.5	174.2	154.8	**127.5**	**101.3**	**77.1**	**55.3**	**35.0**	25.6	19.8	14.4	9.4			
	18	239.3	224.0	208.7	189.5	174.2	154.8	**123.9**	**97.8**	**73.9**	**52.3**	**32.2**	24.3	18.6	13.2	8.3			
	19	239.3	224.0	208.7	189.5	174.2	**152.4**	**120.3**	**94.4**	**70.7**	**49.4**	29.8	23.0	17.3	12.0	7.1			
	20	239.3	224.0	208.7	189.5	174.2	**148.5**	**116.6**	**91.0**	**67.5**	**46.4**	28.4	21.7	16.0	10.8				
	21	239.3	224.0	208.7	189.5	**170.7**	**144.6**	**113.0**	**87.6**	**64.3**	**43.4**	27.0	20.5	14.8	9.6				
	22	239.3	224.0	208.7	**189.1**	**166.7**	**140.7**	**190.3**	**84.1**	**61.1**	**40.4**	25.7	19.0	13.5	8.4				
	23	239.3	224.0	208.7	**185.1**	**162.7**	**136.8**	**105.7**	**80.7**	**57.8**	38.3	24.3	17.7	12.3					
	24	239.3	224.0	208.7	**181.1**	**158.7**	**132.9**	**102.0**	**77.3**	**54.6**	36.8	22.9	16.4	11.0					
	25	239.3	224.0	**205.0**	**177.1**	**154.7**	**129.0**	**98.4**	**73.8**	**51.4**	35.3	21.6	15.1	9.7					
	26	239.3	**223.4**	**201.0**	**173.1**	**150.7**	**125.1**	**94.7**	**70.4**	48.1	33.8	20.4	13.8						
	27	239.3	**219.4**	**197.0**	**169.1**	**146.7**	**121.3**	**91.1**	**67.0**	46.7	32.3	18.8	12.4						
	28	**237.9**	**215.4**	**193.0**	**165.1**	**142.7**	**117.4**	**87.5**	**63.5**	43.1	30.8	17.4	11.1						
	29	**233.9**	**211.4**	**189.0**	**161.1**	**138.7**	**113.5**	**83.8**	**60.1**	43.4	29.3	16.1							
	30	**229.9**	**207.4**	**185.0**	**157.1**	**134.7**	**109.6**	**80.2**	57.1	41.9	27.8	14.7							
Area, In.²		18.41	17.23	16.05	14.58	13.40	11.91	9.97	8.40	6.93	5.58	4.30	3.69	3.17	2.68	2.23	1.70	1.08	0.80
I, In.⁴		502.1	461.0	372.6	279.3	217.0	160.7	107.6	72.5	46.5	28.1	15.2	10.4	7.25	4.79	3.02	1.53	0.666	0.310
r, In.		5.526	5.172	4.819	4.327	4.024	3.674	3.284	2.936	2.592	2.245	1.878	1.683	1.510	1.337	1.164	0.947	0.787	0.623
Weight, lb. ft.		62.58	58.57	54.57	49.56	45.90	40.48	33.91	28.55	23.54	18.97	14.62	12.54	10.79	9.11	7.58	5.79	3.65	2.72

Allowable Fiber Stress per square inch, 13,000 pounds for lengths of 60 radii or under, reduced for length over 60 radii; see Construction Specifications.

Weights do not include details.

Safe loads in "light" type are for ratios of l/r not over 60; in "**heavy**" type, for ratios up to 120 l/r; in "*italic*" type, for ratios not over 200 l/r.



No. 17—Highway Span, Fabricated and Erected by The Manitoba Bridge and Iron Works, Limited

BRIDGES

Years of experience in designing, fabricating and erecting steel bridges of all types permit us to assure satisfaction in even the most difficult undertakings in this line.

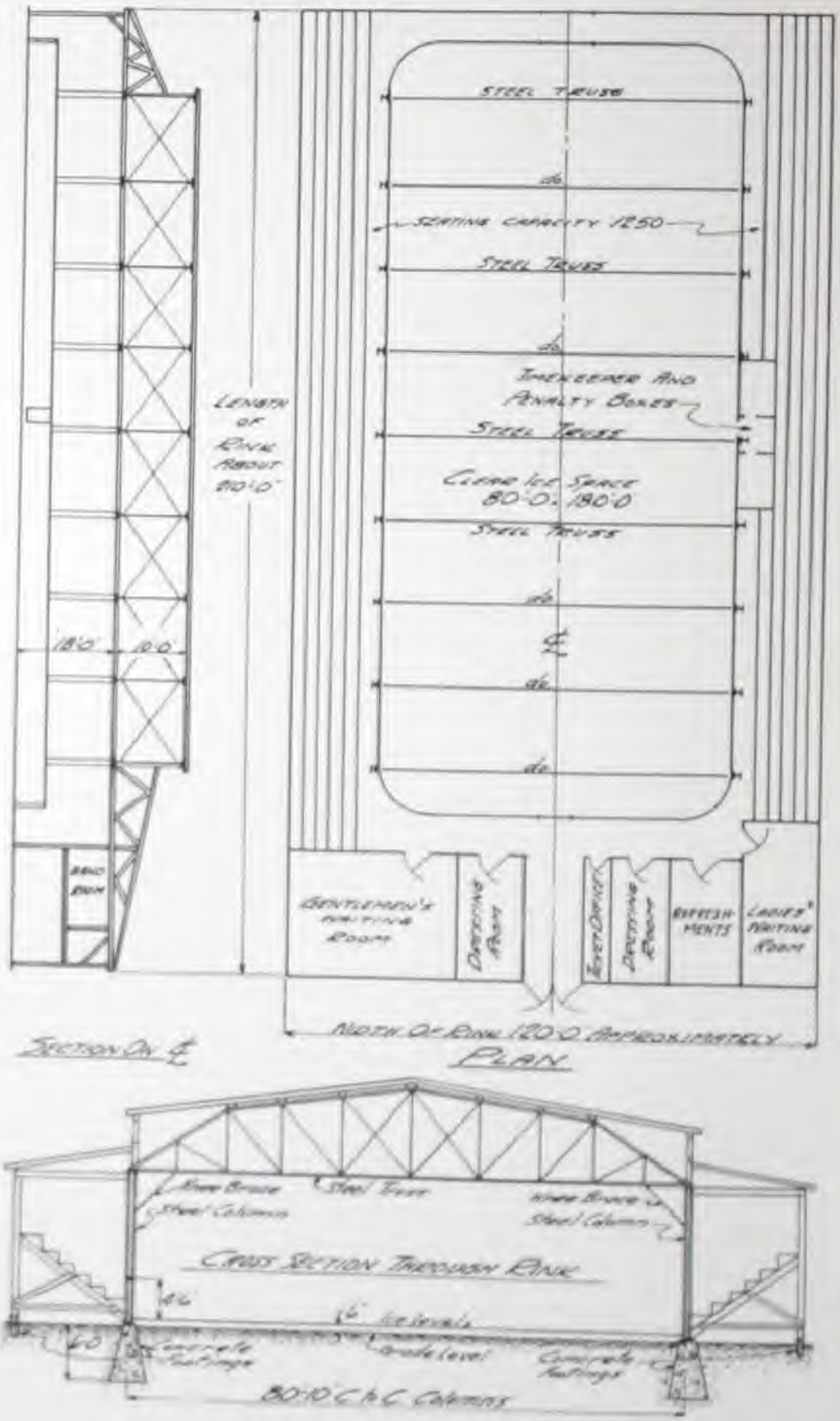
For both the Canadian Pacific Railway and the Canadian National Railways we have constructed numerous railway bridges throughout the western provinces.

For the Canadian Pacific we fabricated and erected the viaduct over the Bow River on the Suffield-Kipp branch, the bridges on that company's line to Drumheller, Alta. and on their line through southern Saskatchewan, as well as on the main line in British Columbia. We have also built bridges on the Kettle Valley Railway at the coast.

For the Canadian National Railways, we fabricated and erected all the bridges on the Calgary-Edmonton line and many others throughout the West and as far east as Port Arthur. On page 159 is illustrated a railway bridge on the Canadian National cut-off at Dona, Ont., fabricated and erected by us.

In the construction of highway bridges our record is no less imposing. Every province of Western Canada has numerous evidences of the creditable work of our organization. The Morris bridge, recently erected by us at Morris, Man., is an excellent example of fine workmanship in handling a difficult contract. Its center span is an unusual piece of work, measuring 356 feet from center to center of bearings. Views of the span and of the steel work may be seen on pages 64 and 145.

We also construct movable opening bridges and, of these, two examples are the Osborne bridge, over the Assiniboine, shown on page 28, and the Lockport bridge, over the locks. Both are Strauss bascule spans, fabricated and erected by us.



No. 18.—Typical Enclosed Skating and Hockey Rink

RINKS

The problem of providing an outlet for the energy of the youthful members of a community during the long months of Canadian winter finds solution in the enclosed rink. Skating, hockey and curling rinks are an acknowledged necessity in towns throughout Western Canada, from the standpoint of health as well as recreation.

On the opposite page appears plan and section of a type of enclosed rink which has proved popular and which we have supplied for various towns in Manitoba, Saskatchewan and Alberta.

The size of rink illustrated is 210 feet by 120 feet, with a clear ice space to conform to hockey regulations, 80 feet by 180 feet. The plan allows of a seating capacity for more than 1250 persons, as well as ample space for dressing and waiting rooms, refreshment booth and box office.

No provision is made in this design for end seating, but this can be arranged by putting in an extra truss at the end, and framing to suit. If so desired, a further extension can be made at the sides for the accommodation of a curling rink; or the seats at one side may be replaced by curling surface.

The design shown illustrates a type of combination steel-and-wood construction. In any rink, the most difficult and expensive portion is the truss-work. The advantages of steel trusses over those of wooden construction are more than sufficient to offset the slight increase in cost.

Shrinkage, in a wooden truss, whether framed or arched, increases with the length of time the truss has been in position. This shrinkage causes distortion in the members and warping in the truss itself. These defects are communicated to the roof covering, resulting in leakage, and necessitating continuous repairs.

With steel truss-work, there is a minimum of such difficulty and inconvenience—a sound roof is the result.

In the plan shown on the opposite page, the columns are placed inside the rail so that the truss span may be the shortest possible. In the case of larger rinks the columns may be located in the wall so that there is no obstruction to the view.

The column footings are concrete carried below frost level. Steel columns of 8 x 8-inch H-section are used for carrying the roof trusses, although in some cases 12 x 12-inch timber posts are used. The latter are rather large and obstruct the view to some extent, but they may be placed back about the middle of the seating. This gives a rather good and economical layout, the saving on the columns helping to balance the extra cost of lengthening the trusses.

The ends of the trusses are framed up in timber so that a row of windows can be put in along the sides, obviating the objectionable necessity of roof skylights, which are so hard to keep watertight.

The roof is made up of timber purlins and 2 x 4-inch or 2 x 6-inch jack rafters, covered with shiplap and prepared roofing. In some cases, corrugated iron is used. The sides are either timber framing or corrugated sheeting. The seating accommodation is framed in timber.

Roof loading conditions in Western Canada are taken into consideration in designing the trusses, which have all necessary roof bracing to take care of wind loads, etc.

The design shown is only one of many we have supplied. We will be pleased to submit designs to suit any required size and conditions on request.

TRUSSES

Roof Trusses—A roof truss is a frame work designed to support the roof covering over large spans, avoiding the use of interior columns. They form a structure of compression and tension members and produce vertical reactions under vertical loads; the total load of the roof, that is, the weight of the truss, purlins, roof covering, ceiling, and often also the snow and wind load, is usually considered a uniformly distributed load, equally divided between the two supports and producing equal and vertical end reactions.

The purlins usually rest on the upper chord of the truss, transmitting to the latte. the load of the roof covering, the wind and snow load, that of the jack rafter and their own, and are often so arranged as to carry the dead load directly to the truss joints or panel points to avoid transverse stresses. The distance between two consecutive joints of the top chord is the panel length, the distance between two adjacent trusses the bay length.

The transverse strength of the sheathing or of the corrugated iron used for the roof covering generally determines the spaces between the jack rafters or the purlins. These purlins or rafters are small steel shapes, such as beams, channels and angles, or wooden beams, if the roof is not of fireproof construction.

The design and selection of the covering depends on local conditions as to snow load, wind load, etc.

Forms of trusses in common use, with rigid bearing supports, are shown by No. 19 on page 70. A large number of different styles of trusses are used, the character of the building deciding the correct style of truss. The diagram shown on page 70 will serve to illustrate the trusses in most general use in building construction.

Snow Loads—Snow load varies according to location and slope of roof. Up to slopes of 20 degrees, the snow load should be taken around 25 pounds per square foot of horizontal roof area, reducing by one pound per degree of slope up to 45 degrees, where no snow load need be considered. Regard should also be given to the possibility of partial snow load with local concentration.

Wind Loads—Wind loads also vary with local conditions and with the slope of the roof. When not fixed by building by-laws, they are usually taken as acting horizontally at 40 pounds per square foot on vertical surfaces of greatly-exposed structures and 30 pounds on less-exposed structures. On inclined surfaces, only the normal components of the wind pressure need be considered. The following table gives the normal wind pressure on sloping roofs for a horizontal pressure of 30 pounds per square foot.

NORMAL WIND PRESSURE, IN POUNDS PER SQUARE FOOT

Slope, Degrees	Pressure per Square Foot, Pounds	Slope, Degrees	Pressure per Square Foot, Pounds	Slope, Degrees	Pressure per Square Foot, Pounds	Slope, Degrees	Pressure per Square Foot, Pounds
5	5.19	20	18.37	35	25.90	50	28.97
10	10.11	25	21.51	40	27.29	55	29.41
15	14.55	30	24.00	45	28.28	60	29.69

For other pressures than 30 pounds per square foot, the values given above change in proportion. For slopes over 60 degrees the values assumed for horizontal pressure are applied.

Combined Roof Loads—Where the roof loads are not fixed by building laws, ordinary roofs up to 30 feet span should carry the following minimum loads per square foot of exposed surface, applied vertically to provide for dead, wind and snow loads.

MINIMUM ROOF LOADS, IN POUNDS PER SQUARE FOOT

Roof Coverings	Roof Load per Square Foot, Pounds
Gravel or tar on boards, flat slope, 1 in 6 or less	30
Composition on boards, steep slope, more than 1 in 6	15
Roofing on 3 inch flat tile or similar concrete	90
Corrugated sheeting on boards or purlins	40
Slate on boards or purlins	30
Slate on 3 inch flat tile or similar concrete	65
Tile on steel purlins	55
Glass	45

For roofs in climates where no snow is likely to occur, reduce these loads by 10 pounds per square foot, but no roof or any part thereof should be designed for a total live and dead load less than 40 pounds per square foot.

ARBITRARY WEIGHTS OF BUILDING MATERIAL

Building Material	Weight per Square Foot, Pounds
Copper, No. 22 B. W. G.	1½
Corrugated galvanized iron, No. 20 B. W. G.	2½
Corrugated galvanized iron, No. 26 B. W. G.	1½
Felt, 2 layers	½
Felt and asphalt or sand-tar	2
Glass, ¼ inch thick	1½
Lath and plaster ceiling	6-8
Lead, ¼ inch thick	7½
Marble, 1 inch thick, with plaster	10
Sheeting, hemlock, 1 inch thick	2
Sheeting, white pine, spruce, 1 inch thick	2½-2½
Sheeting, yellow pine, 1 inch thick	3½
Shingles, for 4 inches, 4 inches to weather	2
Shingles, glass ⅛ to ¼ inch, including frame	4-10
Slag roof, 4 ply, with cement and gravel	8
Slate, ¼ inch thick, 3 inch lap	4½
Slate, ⅜ inch thick, 3 inch lap	6½
Terneplate, IC	½
Terneplate, IX	¾
Tiles (plain), 10½x6½ inches, 3½ inches to weather	18
Tiles (Spanish), 14½x9½ inches, 7½ inches to weather	9½
Zinc, No. 20 B. W. G.	1½

Form of Trusses—A great variety of trusses are used in building construction the form depending on the character of the building.

The trusses in No. 19 are so arranged that the compression members are the shortest members while the tension members are longest. The last four types are for combination wood and rods for which they are well adapted. The flat type are well adapted for tar and gravel covering and it is only necessary to give them enough slope for proper drainage.

No. 19—Forms of Trusses in General Use, except Imported for Light Buildings

Comparative estimates of cost, made for comparing the total cost of roof trusses of the usual types for various spacings indicate that for spans up to 60 feet the most economical spacing is about 12 feet for light loads or about ¼ the span.

For spans of from 80 feet to 100 feet the spacing should be about ⅓ the span for the shorter spans and about 1-5 the span for the longer spans or from 20 feet to 30 feet. In every case local conditions govern and determine the spacing of the trusses regardless of the economic conditions.

Injecting in a roof supported on rigid walls cannot be recommended although the thought must be entertained based on past experience, as to the position here and manner required to give a stiff roof.

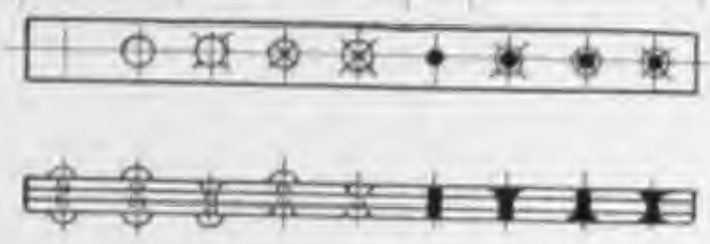
Roof trusses supported on steel columns skirt all the approximate determinations of stresses in bracing, and generally every third or fourth pair of trusses should be rigidly braced with diagonals placed on the plane of the top and bottom chords of the trusses. The connections between trusses being tinkets for lines of struts running transversely the length of the building.

DETAILS FOR PUNCHING AND RIVETTING

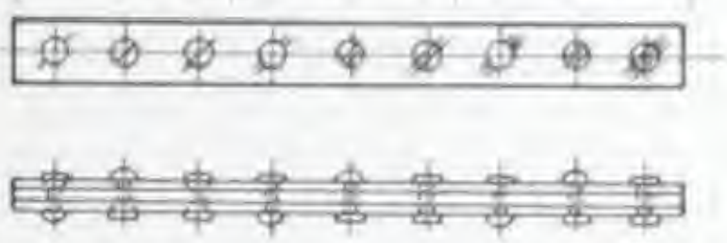
Dimensions in Inches

CONVENTIONAL SIGNS FOR RIVETTING

Shop Rivets				Field Rivets			
Two full heads	Near Side	Far Side	Both Sides	Two full heads	Near Side	Far Side	Both Sides
	Countersunk and Chipped				Countersunk and Chipped		



Shop Rivets								
Countersunk but not chipped Max. Height, $\frac{1}{16}$"			Flattened to $\frac{3}{4}$" high $\frac{7}{8}$" and $\frac{15}{16}$" Rivets			Flattened to $\frac{3}{4}$ high $1\frac{1}{8}$", $1\frac{1}{4}$", $1\frac{3}{8}$" Rivets		
Near Side	Far Side	Both Sides	Near Side	Far Side	Both Sides	Near Side	Far Side	Both Sides



GAUGES FOR ANGLES

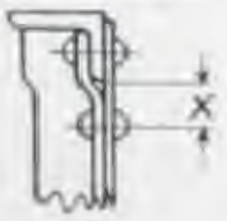
Leg	8	7	6	5	4	$3\frac{1}{2}$	3	$2\frac{1}{2}$	2	$1\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{3}{8}$	$1\frac{1}{4}$	1	$\frac{3}{4}$
g1	$4\frac{1}{2}$	4	$3\frac{1}{2}$	3	$2\frac{1}{2}$	2	$1\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{3}{8}$	1	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{2}$
g2	3	$2\frac{1}{2}$	$2\frac{1}{2}$	2											
g3	3	3	$2\frac{1}{4}$	$1\frac{3}{4}$											
Max. rivet	$1\frac{1}{8}$	1	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{4}$

For column details, 6" leg ($\frac{1}{2}$ inch thick or less) against column shaft, g2 = $1\frac{3}{4}$", g3 = 3".
For diagonal angles, etc., gauge in middle, where rivered leg equals or exceeds 3" for $\frac{3}{4}$" rivets $3\frac{1}{2}$" for $\frac{7}{8}$" rivets.
Use special gauges to adapt work to multiple punch, or to secure desirable details.

CLEARANCE FOR WEB RIVETTING

Size Rivet	Min.	Std.
$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{1}{8}$
$\frac{3}{4}$	1	$1\frac{1}{4}$
$\frac{7}{8}$	$1\frac{1}{8}$	$1\frac{3}{8}$
1	$1\frac{1}{4}$	$1\frac{1}{2}$
$1\frac{1}{8}$	$1\frac{3}{8}$	$1\frac{5}{8}$

RIVETS IN CRIMPED ANGLES

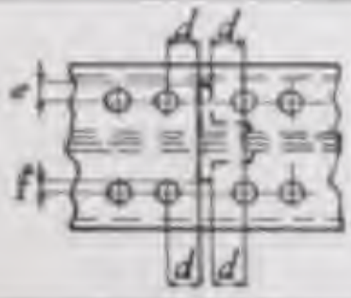


Distance X should be $1\frac{1}{2}$ inches, plus the thickness of chord angles, but never less than 2 inches.

STANDARD RIVET DIES

Size Rivet	Diam. of Die
$\frac{5}{8}$	2
$\frac{3}{4}$	$2\frac{1}{4}$
$\frac{7}{8}$	$2\frac{1}{2}$
1	$2\frac{3}{4}$
$1\frac{1}{8}$	3

CLEARANCE FOR COVER PLATE RIVETTING

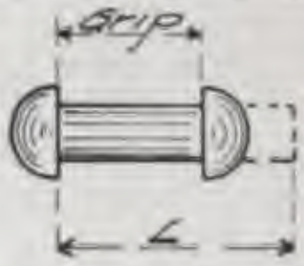


e	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$\frac{1}{2}$	5	$5\frac{1}{2}$	6
d	$2\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{3}{4}$	$2\frac{7}{8}$	$2\frac{7}{8}$	3	$3\frac{1}{8}$	$3\frac{1}{8}$	$3\frac{1}{4}$	$3\frac{1}{4}$	$3\frac{3}{8}$
f	0	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$						
d	$2\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{1}{8}$	2	$1\frac{1}{2}$	0						

RIVETS

RIVET LENGTHS AND APPROXIMATE WEIGHTS PER HUNDRED FOR VARIOUS GRIPS

Weights given are for rivets before driving.

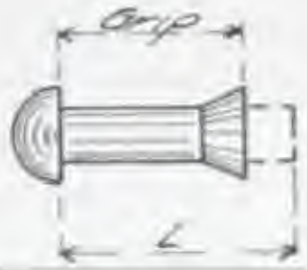


	½-Inch		⅝-Inch		¾-Inch		⅞-Inch		1-Inch	
Grip, In.	L, In.	Weight per 100, Lbs.	L, In	Weight per 100, Lbs.	L, In	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.
½	1½	14.2	1¾	26.3	1⅞	37.1	2	56.7	2⅛	86.3
⅝	1⅝	14.8	1⅞	27.4	2	38.6	2⅛	58.8	2¼	88.8
¾	1¾	15.5	2	28.5	2⅛	40.1	2¼	60.9	2⅜	91.9
⅞	1⅞	16.2	2⅛	29.6	2¼	41.8	2⅜	63.1	2½	94.6
1	2	16.9	2¼	30.6	2⅜	43.3	2½	65.2	2⅝	97.4
1⅛	2⅛	17.6	2⅜	31.7	2½	44.9	2⅝	67.3	2¾	100.2
1¼	2¼	18.3	2½	32.8	2⅝	46.5	2¾	69.6	2⅞	103.0
1⅜	2⅜	19.0	2⅝	33.9	2¾	48.0	2⅞	71.6	3	105.0
1½	2⅝	20.4	2⅞	36.1	3	51.2	3⅛	75.8	3¼	111.3
1⅝	2¾	21.1	3	37.2	3⅛	52.7	3¼	78.0	3⅜	114.1
1¾	3	22.5	3¼	39.4	3⅜	55.8	3½	82.2	3⅝	119.7
1⅞	3⅛	23.2	3⅜	40.4	3½	57.4	3⅝	84.4	3¾	122.4
2	3¼	23.9	3½	41.5	3⅝	59.0	3¾	86.5	3⅞	125.1
2⅛	3⅜	24.6	3⅝	42.6	3¾	60.5	3⅞	88.6	4	128.0
2¼	3½	25.3	3¾	43.7	3⅞	62.1	4	90.8	4⅛	130.8
2⅜	3⅝	26.0	3⅞	44.8	4	63.7	4⅛	92.9	4¼	133.6
2½	3¾	26.7	4	45.9	4⅛	65.2	4¼	95.0	4⅜	136.4
2⅝	3⅞	27.4	4⅛	47.0	4¼	66.8	4⅜	97.1	4½	139.0
2¾	4	28.1	4¼	48.0	4⅜	78.4	4½	99.3	4⅝	141.9
2⅞	4⅛	28.7	4⅜	49.1	4½	69.9	4⅝	101.4	4¾	145.0
3	4⅜	30.1	4⅝	51.3	4¾	73.1	4⅞	105.6	5	150.0
3⅛	4½	30.8	4¾	52.4	4⅞	74.6	5	107.8	5⅛	153.0
3¼	4⅝	31.5	4⅞	53.5	5	76.2	5⅛	109.9	5¼	155.8
3⅜	4¾	32.2	5	54.6	5⅛	77.8	5¼	112.0	5⅜	158.6
3½	4⅞	32.9	5⅛	55.6	5¼	79.3	5⅜	114.2	5½	161.4
3⅝	5	33.6	5¼	56.7	5⅜	80.9	5½	116.3	5⅝	164.2
3¾	5⅛	34.3	5⅜	57.8	5½	82.4	5⅝	118.4	5¾	167.0
3⅞	5¼	35.0	5½	58.9	5⅝	84.0	5¾	120.6	5⅞	169.7
4	5⅜	35.7	5⅝	60.0	5¾	85.6	5⅞	122.7	6	172.5
4⅛	5⅝	36.8	5⅞	62.2	6	88.6	6⅛	126.9	6¼	178.1
4¼	5¾	37.8	6	63.3	6⅛	90.3	6¼	129.1	6⅜	180.9
4⅜	6	39.2	6¼	65.5	6⅜	93.4	6½	133.3	6⅝	186.5
4½	6⅛	39.9	6⅜	66.6	6½	95.1	6⅝	135.4	6¾	189.2
4⅝	6¼	40.6	6½	67.6	6⅝	96.5	6¾	137.6	6⅞	192.0
4¾	6⅜	41.3	6⅝	68.7	6¾	98.1	6⅞	139.7	7	194.8
4⅞	6½	42.0	6¾	69.8	6⅞	99.7	7	141.9	7⅛	197.6
5	6⅝	42.7	6⅞	70.9	7	101.12	7⅛	144.0	7¼	200.3
5⅛					7⅛	102.8	7¼	146.1	7⅜	203.1
5¼					7¼	104.4	7⅜	148.2	7½	205.9
5⅜					7⅜	105.9	7½	150.4	7⅝	208.7
5½					7⅝	108.9	7¾	154.7	7⅞	214.3
5⅝					7¾	111.0	7⅞	156.8	8	217.0
5¾					7⅞	112.5	8	159.0	8⅛	219.8
5⅞					8	114.0	8⅛	161.1	8¼	222.6
6					8⅛	115.5	8¼	163.2	8⅜	224.5

RIVETS

RIVET LENGTHS AND APPROXIMATE WEIGHTS PER HUNDRED FOR VARIOUS GRIPS

Weights given are for rivets before driving.



	½-Inch		⅝-Inch		¾-Inch		⅞-Inch		1-Inch	
Grip, In.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.
½	1⅛	12.2	1¼	22.0	1¼	29.3	1⅜	46.1	1⅜	69.6
⅝	1¼	12.8	1⅜	23.1	1⅜	30.9	1½	48.2	1½	72.2
¾	1⅜	13.4	1½	24.1	1½	32.4	1⅝	50.3	1⅝	74.6
⅞	1½	14.2	1⅝	25.2	1⅝	34.0	1¾	52.5	1¾	77.7
1	1⅝	14.8	1¾	26.3	1¾	35.5	1⅞	54.6	1⅞	80.7
1⅛	1¾	15.5	1⅞	27.4	1⅞	37.1	2	56.7	2	83.3
1¼	1⅞	16.2	2	28.5	2	38.6	2⅛	58.8	2⅛	86.3
1⅜	2	16.9	2⅛	29.6	2⅛	40.1	2¼	61.0	2¼	88.8
1⅝	2¼	18.3	2⅜	31.7	2½	44.9	2½	65.2	2⅜	97.4
1¾	2½	19.7	2⅝	33.9	2¾	48.0	2¾	69.5	2⅞	103.0
1⅞	2⅝	20.4	2¾	35.0	2⅞	49.6	2⅞	71.6	3	105.0
2	2¾	21.1	2⅞	36.1	3	51.2	3	73.7	3⅛	108.5
2⅛	2⅞	21.8	3	37.2	3⅛	52.7	3⅛	75.9	3¼	111.3
2¼	3	22.5	3⅛	38.3	3¼	54.3	3¼	78.0	3⅜	114.1
2⅜	3⅛	23.2	3¼	39.4	3⅜	55.8	3⅜	80.1	3½	116.9
2½	3¼	23.9	3⅜	40.4	3½	57.4	3½	82.3	3⅝	119.7
2⅝	3⅜	24.6	3½	41.5	3⅝	59.0	3⅝	84.4	3¾	122.4
2¾	3½	25.3	3⅝	42.6	3¾	60.5	3¾	86.5	3⅞	125.1
2⅞	3⅝	26.0	3¾	43.7	3⅞	62.1	3⅞	88.6	4	128.0
3	3⅞	27.4	4	45.9	4	63.7	4⅛	92.9	4¼	133.6
3⅛	4	28.1	4⅛	47.0	4⅛	65.2	4¼	95.0	4⅜	136.4
3¼	4⅛	28.7	4¼	48.0	4¼	66.8	4⅜	97.2	4½	139.0
3⅜	4¼	29.4	4⅜	49.1	4⅜	68.4	4½	99.3	4⅝	141.9
3½	4⅜	30.1	4½	50.2	4½	69.9	4⅝	101.4	4¾	145.0
3⅝	4½	30.8	4⅝	51.3	4⅝	71.5	4¾	103.5	4⅞	147.5
3¾	4⅝	31.5	4¾	52.4	4¾	73.1	4⅞	105.7	5	150.0
3⅞	4¾	32.2	4⅞	53.5	4⅞	74.6	5	107.8	5⅛	153.0
4	4⅞	32.9	5	54.6	5	76.2	5⅛	109.9	5¼	155.8
4⅛	5⅛	34.3	5¼	56.7	5¼	79.3	5⅜	114.2	5½	161.4
4¼	5¼	35.0	5⅜	57.8	5⅜	80.9	5½	116.3	5⅝	164.2
4⅜	5½	36.4	5⅝	60.0	5⅝	84.0	5⅝	118.4	5¾	167.0
4½	5⅝	37.1	5¾	61.1	5¾	85.6	5¾	120.6	5⅞	169.7
4⅝	5¾	37.8	5⅞	62.2	5⅞	87.1	5⅞	122.7	6	172.5
4¾	5⅞	38.5	6	63.3	6	88.6	6	124.8	6⅛	175.3
4⅞	6	39.2	6⅛	64.4	6⅛	90.3	6⅛	126.9	6¼	178.1
5	6⅛	39.9	6¼	65.5	6¼	91.8	6¼	129.1	6⅜	180.9
5⅛	.....	.....	.....	.....	6⅜	93.4	6⅜	131.2	6½	184.0
5¼	.....	.....	.....	.....	6½	95.1	6½	133.4	6⅝	186.5
5⅜	.....	.....	.....	.....	6⅝	96.5	6⅝	135.5	6¾	189.2
5½	.....	.....	.....	.....	6⅞	99.7	6⅞	139.8	7	194.8
5⅝	.....	.....	.....	.....	7	101.2	7	142.0	7⅛	197.6
5¾	.....	.....	.....	.....	7⅛	102.8	7⅛	144.1	7¼	200.3
5⅞	.....	.....	.....	.....	7¼	104.4	7¼	146.2	7⅜	203.1
6	.....	.....	.....	.....	7⅜	105.9	7⅜	148.3	7½	205.9

RIVETS

SHEARING AND BEARING VALUES

⅜-INCH RIVETS—Area .1104 Square Inch

Shear	Unit, Lbs. per Sq. In.		7000	8000	9000	10000	11000	12000
	Single Shear per Rivet, Lbs.		770	880	990	1100	1210	1320
	Double Shear per Rivet, Lbs.		1540	1760	1980	2200	2420	2640
Bearing	Unit, Lbs. per Sq. In.		14000	16000	18000	20000	22000	24000
	Thickness, In.	⅛	660	750	840	940	1030	1130
		3/16	980	1130	1270	1410	1550	1690
		¼	1310	1500	1690	1880	2060	2250
		5/16	**1640**	**1880**	**2110**	**2340**	**2580**	**2810**
		⅜	**1910**	**2250**	**2530**	**2810**	**3090**	**3380**

½-INCH RIVETS—Area .1963 Square Inch

Shear	Unit, Lbs. per Sq. In.		7000	8000	9000	10000	11000	12000
	Single Shear per Rivet, Lbs.		1370	1570	1770	1960	2160	2360
	Double Shear per Rivet, Lbs.		2750	3140	3530	3930	4320	4710
Bearing	Unit, Lbs. per Sq. In.		14000	16000	18000	20000	22000	24000
	Thickness, In.	3/16	1310	1500	1690	1880	2060	2250
		¼	1750	2000	2250	2500	2750	3000
		5/16	2190	2500	2810	3130	3440	3750
		⅜	2630	3000	3380	3750	4130	4500
		7/16	**3060**	**3500**	**3940**	**4380**	**4810**	**5250**
		½	**3500**	**4000**	**4500**	**5000**	**5500**	**6000**

⅝-INCH RIVETS—Area .3068 Square Inch

Shear	Unit, Lbs. per Sq. In.		7000	8000	9000	10000	11000	12000
	Single Shear per Rivet, Lbs.		2150	2450	2760	3070	3370	3680
	Double Shear per Rivet, Lbs.		4300	4910	5520	6140	6750	7360
Bearing	Unit, Lbs. per Sq. In.		14000	16000	18000	20000	22000	24000
	Thickness, In.	3/16	1640	1880	2110	2340	2580	2810
		¼	2190	2500	2810	3130	3440	3750
		5/16	2730	3130	3520	3910	4300	4690
		⅜	3280	3750	4220	4690	5160	5630
		7/16	3830	4380	4920	5470	6020	6560
		½	**4380**	**5000**	**5630**	**6250**	**6880**	**7500**
		9/16	**4920**	**5630**	**6330**	**7030**	**7730**	**8440**
		⅝	**5470**	**6250**	**7040**	**7810**	**8590**	**9380**

Values in "**heavy**" type are greater than double shear.

RIVETS

SHEARING AND BEARING VALUES

⅞-INCH RIVETS Area .4418 Square Inch

Single	One Ton per Sq. In.	7280	8190	9100	10920	11830	12740
	Single Shear per Rivet, Lbs.	3140	3530	3930	4710	5100	5500
	Double Shear per Rivet, Lbs.	6280	7060	7850	9420	10200	11000
Bearing	One Ton per Sq. In.	14000	16000	18000	24000	28000	32000
Plate ½ Inch Thick	⅝	8750	9840	10940	13120	14220	15310
	¾	10500	11810	13120	15740	17060	18370
	⅞	12240	13780	15310	18370	19900	21430
	1	13990	15750	17500	20990	22750	24490
	1⅛	15740	17710	19680	23620	25590	27550
	1¼	17490	19680	21870	26240	28430	30610
	1⅜	19240	21650	24060	28870	31270	33670
	1½	20990	23620	26240	31490	34110	36730
	1⅝	22740	25590	28430	34110	36950	39790
	1¾	24490	27560	30610	36730	39790	42850
	1⅞	26240	29520	32800	39360	42640	45910
	2	27990	31490	34990	41990	45490	48970

¾-INCH RIVETS Area .6013 Square Inch

Single	One Ton per Sq. In.	9910	11150	12390	14870	16110	17350
	Single Shear per Rivet, Lbs.	4270	4810	5350	6420	6950	7490
	Double Shear per Rivet, Lbs.	8540	9610	10690	12830	13900	14970
Bearing	One Ton per Sq. In.	18000	21000	24000	30000	33000	36000
Plate ½ Inch Thick	⅝	11250	13120	15000	18750	20620	22500
	¾	13500	15750	18000	22500	24750	27000
	⅞	15750	18370	21000	26250	28870	31500
	1	18000	21000	24000	30000	33000	36000
	1⅛	20250	23620	27000	33750	37120	40500
	1¼	22500	26240	30000	37500	41240	45000
	1⅜	24750	28870	33000	41250	45370	49500
	1½	27000	31490	36000	45000	49500	54000
	1⅝	29250	34110	39000	48750	53620	58500
	1¾	31500	36730	42000	52500	57750	63000
	1⅞	33750	39360	45000	56250	61870	67500
	2	36000	42000	48000	60000	66000	72000

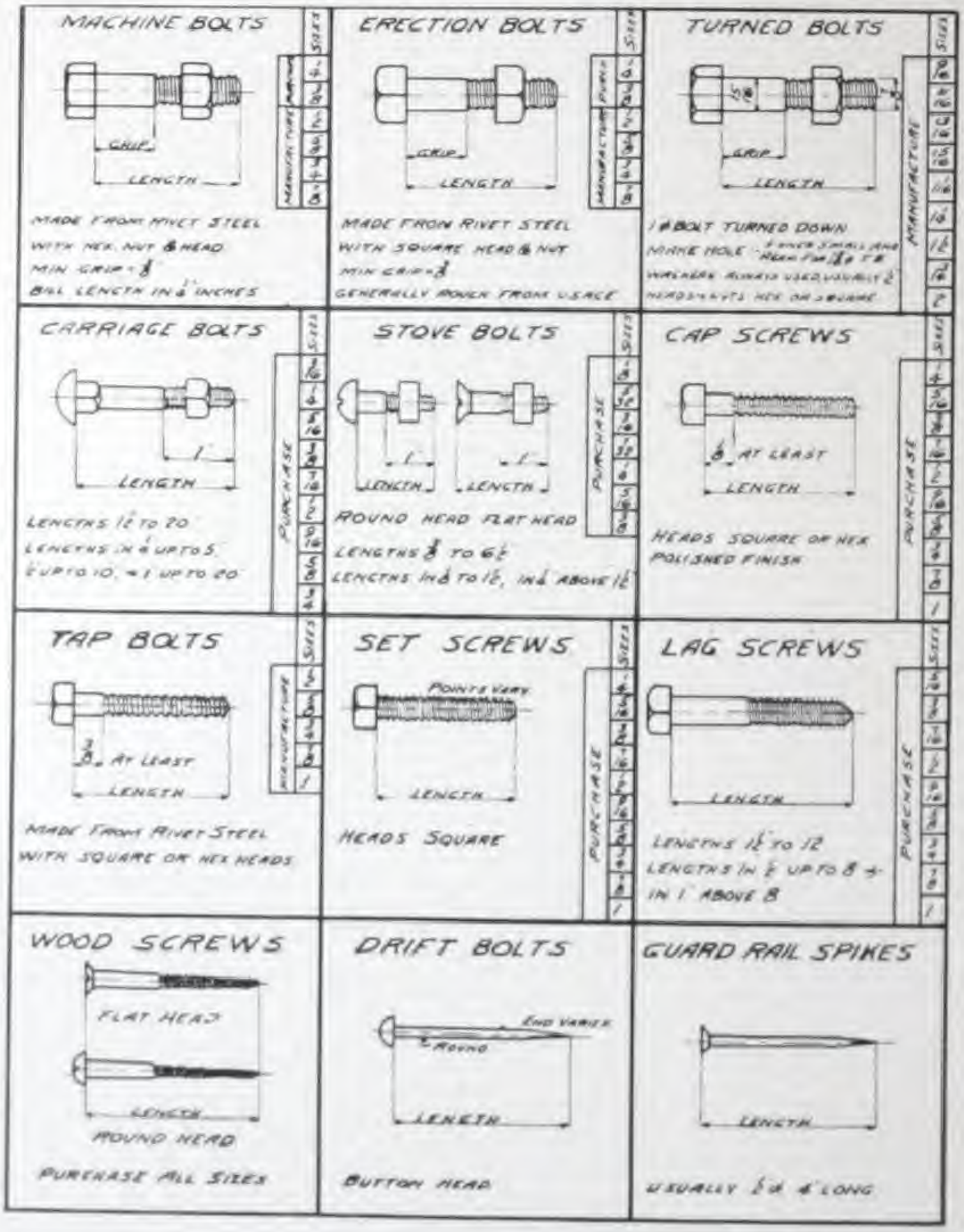
1-INCH RIVETS Area .7854 Square Inch

Single	One Ton per Sq. In.	12940	14560	16180	19420	21040	22660
	Single Shear per Rivet, Lbs.	5580	6280	6980	8380	9080	9780
	Double Shear per Rivet, Lbs.	11160	12570	13960	16760	18160	19560
Bearing	One Ton per Sq. In.	24000	28000	32000	40000	44000	48000
Plate ½ Inch Thick	⅝	15000	17500	20000	25000	27500	30000
	¾	18000	21000	24000	30000	33000	36000
	⅞	21000	24500	28000	35000	38500	42000
	1	24000	28000	32000	40000	44000	48000
	1⅛	27000	31500	36000	45000	49500	54000
	1¼	30000	35000	40000	50000	55000	60000
	1⅜	33000	38500	44000	55000	60500	66000
	1½	36000	42000	48000	60000	66000	72000
	1⅝	39000	45500	52000	65000	71500	78000
	1¾	42000	49000	56000	70000	77000	84000
	1⅞	45000	52500	60000	75000	82500	90000
	2	48000	56000	64000	80000	88000	96000

Replace by "shells" every time three occur.
Values in "Bearing" values are governed by Article eleven.

BOLTS AND SCREWS

The illustration below shows the more common types of bolts and screws in general use. It should prove useful, as discussion often arises concerning the differences between certain types.



No. 20—Types of Bolts and Screws

Information as to sizes, lengths and finishes of the bolts and screws shown above is given in the text of the accompanying pages of this section.

MACHINE BOLTS

The rules used for design of thread, number of threads per inch, and sizes for hexagon and nuts are those commonly known as U. S. Standard, as follows:

No. 21. Shape of Thread.

Short diameter of rough nut or rough head is equal to one and a half times the diameter of bolt, plus 1/8". Thickness of rough nut equals diameter of bolt. Thickness of rough head equals one half the short diameter of head.

DIMENSIONS OF HEADS AND NUTS.

Finished			Mixed			Iron		
	Hexagonal	Side of Square	Square	Hexagonal	Side of Square	Square

BOLTS WITH SQUARE HEADS AND NUTS

WEIGHT IN POUNDS PER 100 BOLTS

Length Under Head, Inches	Diameter of Bolt, Inches								
	¾	⅝	½	⅜	¼	⅛	⅞	1	
1	4	7	11	15	22	37	56		
1¼	4	7	11	16	23	39	59		
1½	5	8	12	17	24	41	62		
1¾	5	8	13	18	26	43	64		
2	5	9	14	19	27	45	67	101	144
2¼	6	9	15	20	28	47	71	104	150
2½	6	10	15	21	30	49	74	109	155
2¾	6	10	16	22	31	51	77	113	161
3	7	11	17	24	33	54	80	117	167
3½	7	12	18	25	35	58	86	126	178
4	8	13	20	28	38	62	92	134	189
4½	9	14	21	30	41	66	98	142	198
5	10	15	23	32	43	71	104	151	209
5½	10	16	25	34	46	75	111	159	220
6	11	17	26	36	49	79	117	168	232
6½			28	38	52	84	123	176	243
7			29	40	55	88	129	185	254
7½			31	42	57	92	136	193	265
8			32	45	60	97	142	202	276
9			34	49	65	105	154	218	298
10				53	71	114	167	235	320
12				61	82	131	192	269	364
14					93	148	217	303	409
Per Inch Additional	1 4	2 2	3 1	4 3	5 6	8 7	12 5	17 0	22 3

SQUARE NUTS AND BOLT HEADS

WEIGHTS IN POUNDS FOR ONE HEAD AND ONE NUT

Diameter of Bolt, Inches	1¼	1½	1¾	2	2½	3
Square Head and Nut	2 05	3 51	5 48	8 08	15 5	26 2
Weight of Shank per Inch	.3477	.5007	.6815	.8900	1 361	2 003

BOLTS WITH HEXAGONAL HEADS AND NUTS

WEIGHT IN POUNDS PER 100 BOLTS

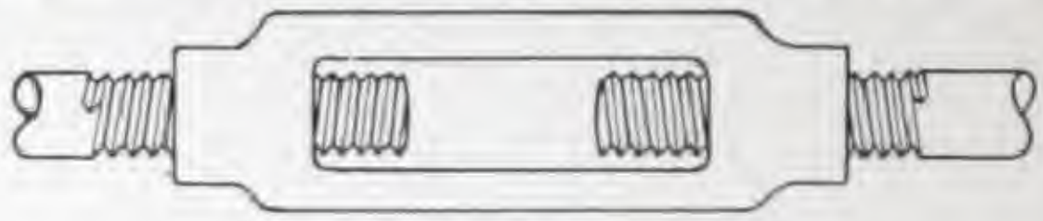
Length Under Head, Inches	Diameter of Bolt, Inches					Length Under Head, Inches	Diameter of Bolt, Inches				
	½	⅝	¾	⅞	1		½	⅝	¾	⅞	1
1	19	33	52			8	56	93	137	194	264
1¼	20	34	54			8½	60	98	143	202	274
1½	22	36	57			9	63	100	149	210	285
1¾	23	38	60			9½	66	103	156	219	296
2	24	40	63	93	132	10	69	109	162	227	307
2¼	26	43	66	97	137	10½	71	114	168	236	318
2½	27	45	69	101	143	11	74	119	174	244	329
2¾	29	47	72	105	148	11½	77	123	181	253	341
3	30	49	75	109	154	12	80	127	187	261	352
3¼	31	51	78	114	160	12½	82	131	193	270	363
3½	33	54	82	118	165	13	85	136	199	278	374
3¾	34	56	85	122	171	13½	88	140	206	287	385
4	35	58	88	126	176	14	91	144	212	295	396
4¼	37	60	90	130	182	14½	92	148	218	304	407
4½	38	62	94	134	188	15	96	152	225	312	418
4¾	40	64	97	138	193	15½	99	157	231	321	430
5	41	66	100	143	197	16	102	161	237	329	441
5¼	42	69	103	147	202	16½	105	165	243	339	452
5½	44	71	106	151	208	17	107	170	250	346	463
5¾	45	73	109	156	213	17½	110	174	256	355	474
6	46	75	112	160	219	18	113	177	262	364	485
6¼	48	77	115	164	225	18½	116	182	268	372	496
6½	49	79	118	168	230	19	119	187	275	381	507
6¾	51	81	122	173	236	19½	123	191	281	390	518
7	52	84	125	177	241	20	124	196	287	398	530
7¼	53	86	128	181	247						
7½	55	88	131	185	253						
7¾	56	90	134	190	258						
Per Inch Additional	3.6	4.7	12.3	17.0	22.3	Per Inch Additional	3.0	4.7	12.3	17.0	22.3

HEXAGONAL NUTS AND BOLT HEADS

WEIGHTS IN POUNDS FOR ONE HEAD AND ONE NUT

Diameter of Bolt, Inches	1¼	1½	1¾	2	2½	3
Hexagon Head and Nut	1.78	2.48	3.61	6.79	13.0	22.0
Weight of Shank per Inch	.3427	.5067	.6913	.8881	1.201	2.003

DROP-FORGED STEEL STANDARD TURNBUCKLES



No. 22—Stand rd Turnbuckle

These Turnbuckles are drop-forged from the bar, are free from welds and seams, thus making them absolutely reliable and giving a tensile strength of 60,000 pounds or more per square inch.

Diameter of Stub Ends, Inches	Opening between Heads, Inches	Length of Buckle With Ends, Inches	Weights			
			With Stub		Without Stub	
			Lb.	Oz.	Lb.	Oz.
1/2	6	22	1	8	0	12
5/8	6	22	2	8	1	2
3/4	6	23	3	8	1	6
7/8	6	24	4	8	2	0
1	6	25	6	8	2	14
1 1/8	6	25	8	8	3	8
1 1/4	6	26	10	12	5	0
1 3/8	6	27	13	0	6	0
1 1/2	6	27	16	0	7	0
1 5/8	6	28	19	0	8	12
1 3/4	6	28	21	8	10	0
1 7/8	6	29	26	8	12	8
2	6	29	30	8	14	0
2 1/4	6	30	45	0	19	0

Larger sizes can be supplied but are not carried in stock. Turnbuckles with longer length between heads can also be furnished.

SQUARE WROUGHT WASHERS

Size Square, Inches	Thickness, Inches	Size of Hole, Inches	Size of Bolt, Inches	Average Number per 100 Pounds
1 1/2	1/8	7/16	3/8	1,300
1 3/4	1/8	1/2	7/16	1,100
2	3/16	9/16	1/2	500
2 1/4	3/16	11/16	5/8	390
2 1/4	1/4	23/32	5/8	315
2 1/4	5/16	11/16	3/4	426
2 1/4	5/16	3/4	47/64	409
2 1/2	1/4	27/32	3/4	250
3	1/4	11/16	3/4	166
3	1/4	31/32	7/8	165
3 1/2	5/16	1-3/32	1	87
4	5/16	1 1/4	1 1/8	65
4 1/2	5/16	1 3/8	1 1/4	48
5	3/8	1 1/2	1 3/8	40
6	3/8	1 5/8	1 1/2	28
6	3/8	1 7/8	1 3/4	24
6	3/8	2 1/8	2	21

These can be supplied either black hot galvanized or electric galvanized.

SQUARE PLATE WASHERS

Heavy plate washers are furnished in large numbers for all classes of structural work. As we always carry a large stock of plates of all sizes and thicknesses, these washers can be turned out very promptly. When ordering always state width, length and thickness of plate, also size of bolt hole.

CUT, PRESSED OR PLATE WASHERS

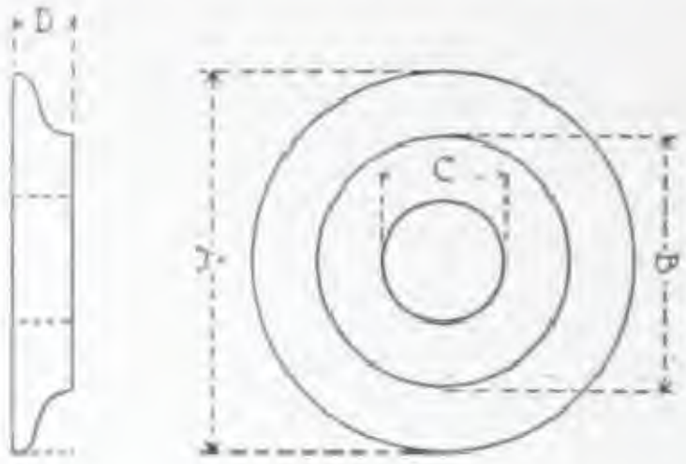
We can supply from stock standard cut, pressed or plate washers in the sizes tabulated below for cut round washers.

SPECIFICATIONS FOR CUT ROUND WASHERS

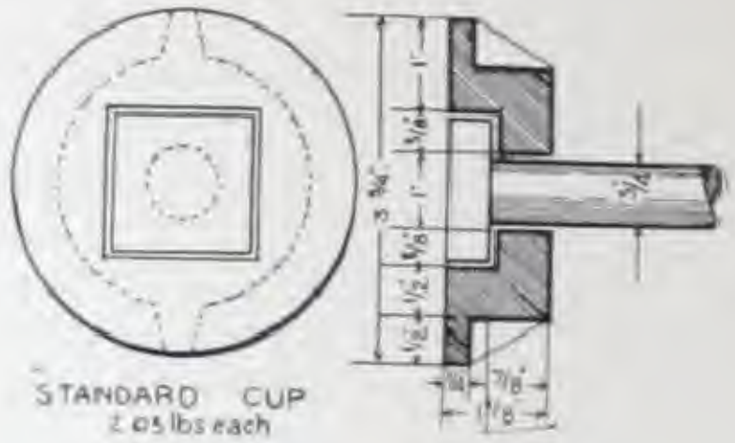
Outside Diameter In.	Size of Hole In.	Thickness Wire Gauge No.	Size of Bolt In.	Average Number in 100 lbs.
⅞	5/16	18	¼	39,400
1	⅜	16	5/16	15,880
1⅛	⅜	16	⅜	11,250
1¼	⅜	14	7/16	6,800
1⅜	7/16	13	½	4,300
1½	½	12	9/16	2,920
1⅝	½	12	⅝	2,250
1¾	9/16	10	11/16	1,320
1¾	⅝	10	¾	1,580
2	¾	10	⅞	1,010
2	⅞	10	⅞	1,110
2⅛	⅞	9	15/16	860
2¼	1	9	1	625
2⅜	1⅛	9	1⅛	670
2¾	1⅜	9	1⅜	820
2¾	1⅜	9	1¼	570
3	1⅜	9	1¼	400
3¼	1½	8	1⅜	300
3½	1⅝	8	1½	280
3¾	1¾	8	1⅝	240
4	1⅞	8	1¾	215
4¼	2	8	1⅞	190
4½	2⅛	8	2	175

CAST IRON WASHERS

We can supply on short notice standard cast washers in the sizes tabulated below. Pressed washers, are referred to on page 81. Cup washers, as shown by No. 24 below, and cast iron separators, for use in timber bridge construction, are obtainable in all sizes and patterns.



No. 23—Standard Cast "Ogee" Washer.



No. 24—Cast Iron Cup Washer

Dimensions and Weights of Standard Cast Washers

Diameter of Bolt, Inch	A	B	C	D	Weight in Pounds
$\frac{1}{2}$	$2\frac{5}{8}$	$1\frac{3}{4}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{1}{2}$
$\frac{5}{8}$	3	$1\frac{7}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{3}{4}$
$\frac{3}{4}$	$3\frac{1}{4}$	$2\frac{1}{8}$	$\frac{13}{16}$	$\frac{7}{8}$	$1\frac{1}{4}$
$\frac{7}{8}$	$3\frac{3}{4}$	$2\frac{1}{2}$	$\frac{15}{16}$	$\frac{7}{8}$	$1\frac{1}{2}$
1	4	$2\frac{3}{4}$	$1\frac{1}{16}$	$1\frac{1}{8}$	$2\frac{1}{2}$
$1\frac{1}{8}$	$4\frac{3}{4}$	$2\frac{3}{4}$	$1\frac{3}{16}$	$1\frac{1}{8}$	3
$1\frac{1}{4}$	6	3	$1\frac{5}{16}$	$1\frac{3}{8}$	$5\frac{3}{4}$
$1\frac{1}{2}$	$6\frac{1}{4}$	$3\frac{1}{4}$	$1\frac{5}{8}$	$1\frac{1}{2}$	6
$1\frac{3}{4}$	$7\frac{1}{4}$	$3\frac{3}{4}$	$1\frac{7}{8}$	$1\frac{3}{4}$	$9\frac{1}{2}$
2	$8\frac{1}{4}$	$4\frac{1}{4}$	$2\frac{1}{8}$	2	$17\frac{1}{4}$

The letters A, B, C, D refer to illustration No. 23 above.

SASH WEIGHTS

Our facilities for manufacturing sash weights are exceptional and we sell large numbers of them in Winnipeg and throughout Western Canada.

Send list of sizes wanted and we will quote you prices.

No. 25 (At Left)—Cast Iron Sash Weights

STRUCTURAL TIMBER

TIMBER COLUMNS

The safe load tables of wooden columns which follow, based upon the working unit stresses adopted by the American Railway Engineering Association, give the allowable direct compressive loads for square and round columns.

The safe loads of rectangular columns may be found from the safe loads of square columns by direct proportion of areas, using the safe load unit stress of the square column whose side is equal to the least side of the rectangular section.

The following table gives the safe load in pounds per square inch of sectional area for ratios of

$$\frac{l}{d} = \frac{\text{effective length of column, in inches}}{\text{least side or diameter, in inches}},$$

ranging between limits of 15 and 30.

Unit Working Stresses in Pounds per Square Inch

$\frac{l}{d}$	Longleaf Pine	Douglas Fir	Spruce	Tamarack	Red Cedar,	Norway Pine
	1300 × (1—l/d60)	1200 × (1—l/d60)	1100 × (1—l/d60)	1000 × (1—l/d60)	900 × (1—l/d60)	800 × (1—l/d60)
15	975	900	825	750	675	600
16	953	880	807	733	660	587
17	931	860	788	717	645	573
18	910	840	770	700	630	560
19	888	820	752	683	615	547
20	867	800	733	667	600	533
21	845	780	715	650	585	520
22	823	760	697	633	570	507
23	802	740	678	617	555	493
24	780	720	660	600	540	480
25	758	700	642	583	525	467
26	737	680	623	567	510	553
27	715	660	605	550	495	440
28	693	640	587	533	480	427
29	672	620	568	517	465	413
30	650	600	550	500	450	400

SQUARE TIMBER COLUMNS
SAFE LOADS IN THOUSANDS OF POUNDS

	Lgth. Feet	Side of Square, Inches								
		4	6	8	10	12	14	16	18	20
LONGLEAF PINE WHITE OAK 1200 (1—1 (0)(1)	5	**15 6**								
	6	15 6								
	7	14 6								
	8	13 5	**35 1**							
	9	12 5	34 3							
	10	11 4	32 8	**62 4**						
	11	10 4	31 2	62 4						
	12		29 6	60 3						
	14		28 1	58 2	**97 5**					
	16		25 0	54 1	93 6	**140 4**				
	18			49 9	88 4	137 3	**191 1**			
	20			45 8	83 2	131 0	189 3	**249 6**		
				41 6	78 0	124 8	182 0	249 6	315 9	390 0
DOUGLAS FIR WESTERN HEMLOCK 1200 (1—1 (0)(1)	5	**14 4**								
	6	14 4								
	7	13 4								
	8	12 5	**32 4**							
	9	11 5	31 7							
	10	10 6	30 2	**57 6**						
	11	9 6	28 8	57 6						
	12		27 4	55 7						
	14		25 9	53 8	**90 0**					
	16		24 0	49 9	86 4	**129 6**				
	18			46 1	81 6	126 7	**176 4**			
	20			42 2	76 8	121 0	174 7	**230 4**		
				38 4	72 0	115 2	168 0	230 4	291 6	360 0
SHORTLEAF PINE SPRUCE 1100 (1—1 (0)(1)	5	**13 2**								
	6	13 2								
	7	12 3								
	8	11 4	**29 7**							
	9	10 6	29 0							
	10	9 7	27 7	**52 8**						
	11	8 8	26 4	52 8						
	12		25 1	51 0						
	14		23 8	49 3	**82 5**					
	16		21 1	45 8	79 2	**118 8**				
	18			42 2	74 8	116 2	**161 7**			
	20			38 7	70 4	110 9	160 2	**211 2**		
				35 2	66 0	105 6	154 0	211 2	267 3	330 0
WHITE PINE TAMARACK 1000 (1—1 (0)(1)	5	**12 0**								
	6	12 0								
	7	11 2								
	8	10 4	**27 0**							
	9	9 6	26 4							
	10	8 8	25 2	**48 0**						
	11	8 0	24 0	48 0						
	12		22 8	46 4						
	14		21 6	44 8	**75 0**					
	16		19 2	41 6	72 0	**108 0**				
	18			38 4	68 0	105 6	**147 0**			
	20			35 2	64 0	100 8	145 6	**192 0**		
				32 0	60 0	96 0	140 0	192 0	243 0	300 0

Loads in "**heavy**" type above horizontal lines are the maximum allowable safe loads

RECTANGULAR TIMBER BEAMS
ONE INCH THICK
MAXIMUM SAFE LOADS AND LIMITING SPANS

	Species of Timber	Depth of Beam, Inches											
		2	4	6	8	10	12	14	16	18	20	22	24
Max. Safe Loads Lbs.	Douglas Fir	293	587	880	1173	1467	1760	2053	2347	2640	2933	3227	3520
	Spruce	187	373	560	747	933	1120	1307	1493	1680	1867	2053	2240
Min. Spans, Feet	Douglas Fir	1.8	3.6	5.5	7.3	9.1	10.9	12.8	14.6	16.4	18.2	20.0	21.9
	Spruce	2.4	4.9	7.1	9.5	11.9	14.3	16.7	19.0	21.4	23.8	26.2	28.6

MAXIMUM SPANS IN FEET
For Deflections = 1/360 Span

Species of Timber	Depth of Beam, Inches											
	2	4	6	8	10	12	14	16	18	20	22	24
Douglas Fir	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.0	15.4	16.7
Spruce	1.5	2.9	4.4	5.8	7.3	8.7	10.2	11.6	13.1	14.6	16.0	17.5

COEFFICIENT OF DEFLECTION FOR PERMANENT LOADS

Span, Feet	Douglas Fir	Spruce	Span, Feet	Douglas Fir	Spruce	Span, Feet	Douglas Fir	Spruce
1	0.05	0.05	15	10.74	10.31	29	40.14	38.52
2	0.19	0.18	16	12.22	11.73	30	42.96	41.22
3	0.43	0.41	17	13.79	13.24	31	45.87	44.01
4	0.76	0.73	18	15.47	14.84	32	48.88	46.90
5	1.19	1.15	19	17.23	16.53	33	51.98	49.88
6	1.72	1.65	20	19.09	18.32	34	55.18	52.95
7	2.34	2.24	21	21.05	20.20	35	58.47	56.11
8	3.06	2.93	22	23.10	22.17	36	61.86	59.36
9	3.87	3.71	23	25.25	24.23	37	65.34	62.70
10	4.77	4.58	24	27.49	26.38	38	68.92	66.14
11	5.78	5.54	25	29.83	28.63	39	72.60	69.66
12	6.87	6.60	26	32.27	30.96	40	76.37	73.28
13	8.07	7.74	27	34.80	33.39			
14	9.36	8.98	28	37.42	35.91			

RECTANGULAR TIMBER BEAMS—DOUGLAS FIR

ONE INCH THICK

ALLOWABLE UNIFORM LOAD IN POUNDS

Maximum Bending Stress, 1200 Pounds per Square Inch

Span in Feet	Depth of Beam in Inches											
	2	4	6	8	10	12	14	16	18	20	22	24
	293											
2	267											
3	178	**587**										
4	133	533										
5	107	427										
			880									
6	89	356	800									
7	76	305	686	**1173**								
8	67	267	600	1067								
9		237	533	948	**1467**							
10		213	480	853	1333							
						1760						
11		194	436	776	1212	1745						
12		178	400	711	1111	1600	**2053**					
13			369	656	1026	1477	2010					
14			343	610	952	1371	1867	**2347**				
15			320	569	889	1280	1742	2276				
16			300	533	833	1200	1633	2133	**2640**			
17				502	784	1129	1537	2008	2541			
18				474	741	1067	1452	1896	2400	**2933**		
19				449	702	1011	1375	1796	2274	2807	**3227**	
20				427	667	960	1307	1707	2160	2667	3227	
21					635	914	1244	1625	2057	2540	3073	**3520**
22					606	873	1188	1552	1964	2424	2933	3491
23					580	835	1136	1484	1878	2319	2806	3340
24					556	800	1089	1422	1800	2222	2689	3200
25						768	1045	1366	1728	2133	2581	3072
26						738	1005	1313	1662	2051	2482	2954
27						711	968	1264	1600	1975	2390	2843
28						686	933	1219	1543	1905	2305	2743
29							901	1177	1490	1838	2225	2648
30							871	1138	1440	1778	2151	2560
31							843	1101	1394	1720	2082	2477
32							817	1067	1350	1667	2017	2400
33								1034	1309	1616	1956	2327
34								1004	1271	1569	1898	2259
35								975	1234	1524	1844	2194
36								948	1200	1481	1793	2133
37									1168	1441	1744	2074
38									1137	1404	1698	2021
39									1108	1368	1655	1969
40									1080	1333	1613	1920

*Loads in "**heavy**" type indicate the limit for economy in view of the horizontal deflection of the grain.*

RECTANGULAR TIMBER BEAMS—SPRUCE

ONE INCH THICK

ALLOWABLE UNIFORM LOAD IN POUNDS

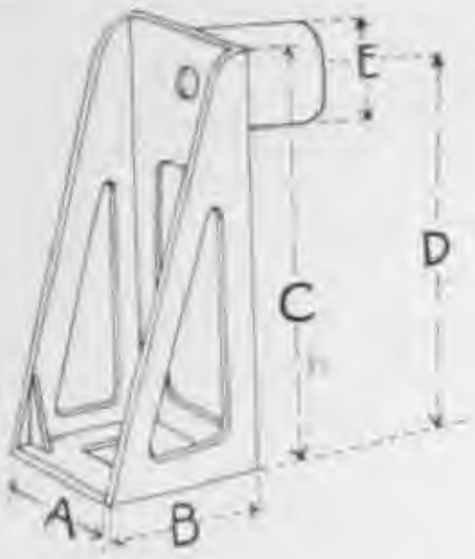
Maximum Bending Stress, 1000 Pounds per Square Inch

Span in Feet	Depth of Beam in Inches											
	2	4	6	8	10	12	14	16	18	20	22	24
2	**187**											
3	148											
4	111	**373**										
5	89	356										
6	74	296										
7	63	254	**560**									
8	56	222	500									
9		198	444	**747**								
10		178	400	711								
11		162	364	646	**933**							
12		148	333	593	926							
13			308	547	855							
14			286	508	794	**1120**						
15			267	474	741	1067						
16			250	444	694	1000	**1307**					
17				418	654	941	1281					
18				395	617	889	1210					
19				374	585	842	1146	**1493**				
20				356	556	800	1089	1422				
21					529	762	1037	1354	**1680**			
22					505	727	990	1293	1636			
23					483	696	947	1237	1565	**1867**		
24					463	667	907	1185	1500	1852		
25						640	871	1138	1440	1778		
26						615	838	1094	1385	1709	**2053**	
27						593	807	1053	1333	1646	1992	
28						571	778	1016	1286	1587	1921	**2240**
29							751	981	1241	1533	1854	2207
30							726	948	1200	1483	1793	2133
31							703	918	1161	1434	1735	2065
32							683	889	1125	1389	1681	2000
33								862	1091	1347	1630	1939
34								837	1059	1307	1582	1882
35								813	1029	1270	1537	1829
36								790	1000	1235	1494	1778
37									973	1201	1453	1730
38									947	1169	1415	1684
39									923	1140	1379	1641
40									900	1111	1344	1600

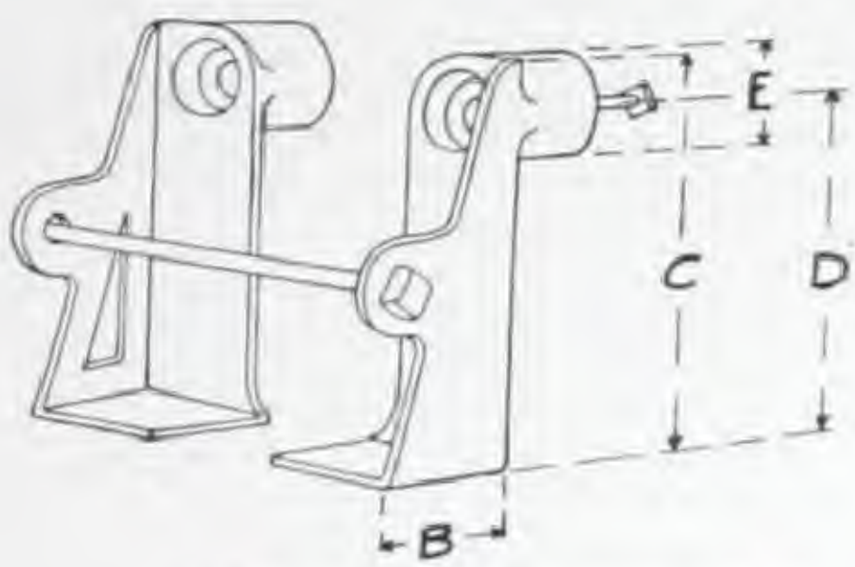
Loads in "heavy" type indicate the limit for safeguard to shear in the horizontal direction of the grain

JOIST HANGERS

The old method of framing by mortise and tenon is obsolete. The use of joist hangers reduces joist-shrinkage to a minimum. Building construction experts find that all headers six feet long or over should be carried on joist hangers, while all framing in warehouses and first-class buildings should be done by means of means of joist hangers.



No. 26—Duplex Joist Hanger



No. 27—Duplex Joist Hangers, in Pairs

SPECIFICATIONS FOR DUPLEX JOIST HANGERS

No.	Dimensions, Inches					Length Lug, In.	Carries Joist, Sizes, In.	Ship. Wt., Lbs.
	A	B	C	D	E			
10	2	3	5¾	5	1½	1¾	2 x 6 to 2 x 10	2¼
14	2	3	8	7	1¾	2	2 x 12 to 2 x 16	3⅓
15	3	3	5¾	5	1⅝	2¼	3 x 6 to 3 x 10	2¾
18	2½	3	8	7	1¾	2½	2½ x 6 to 2½ x 16	3½
20	4	3	5¾	5	1¾	2	4 x 6 to 4 x 10	3
21	3	3	8	7	1⅞	2½	3 x 12 to 3 x 14	3
21X	3	3	10	9	1⅞	2½	3 x 16 to 3 x 20	4¾
28	4	3½	8¼	7	1⅜	2¾	4 x 12 to 4 x 14	4½
28X	4	3½	10	9	2⅜	2⅞	4 x 16 to 4 x 20	7½
53	5	3½	8¼	7	2⅜	3	5 x 8 to 5 x 16	5½
16	6	3½	6	5	2	2¾	6 x 6 to 6 x 9	4
60	6	3½	8¼	7	2⅜	3	6 x 10 to 6 x 12	6⅓
60X	6	4	9½	8	2⅜	3	6 x 14 to 6 x 16	8¾
80	8	4	8¼	7	2⅜	3¼	8 x 8 to 8 x 12	10½
90	8	4	9½	8	2⅜	3	8 x 16 to 8 x 18	14
35R 35L		3¾	8¼	7	2⅜	3¼	8 x 8 to 8 x 14 10 x 10 to 10 x 14	9½ pr.
75R 75L		4¼	11½	10	2⅞	3½	10 x 16 to 10 x 18	19½ pr.

Nos. 35 R and L and 75 R and L are used in pairs as shown in illustration No. 27 above. Weights of these are per pair, without bolts.

WALL HANGERS

In a warehouse intended to be constructed on slow burning principle the floor beams and girders should be anchored to and supported by the walls in such a way that in case the beams are burnt through the ends may fall without injuring the wall, and where large timbers are used provision should be made against the possibility of dry rot. When the wall hanger is used no hole is left in the wall and the saving of six inches in the length of the timber is effected which in some cases would be a consideration.

The Dupler hanger, an ideal hanger for general construction use, is shown by No. 28, on the right. In heavier work, an extra durable type of this style hanger, shown below is used. Tables showing the size of joist carried by each size of wall hanger, and shipping weights of hangers, are given herewith.

No. 28—*Dupler Wall Hanger*

No.	Carries Joist, Size, In.	Shipping Weight, Lbs.	No.	Carries Joist, Size, In.	Shipping Weight, Lbs.
100	2 x 6 to 2 x 12	2¼	280	4 x 12 to 4 x 18	6¾
140	2 x 14 to 2 x 18	3½	500	5 x 8 to 5 x 16	10
150	3 x 6 to 3 x 12	4	600	6 x 8 to 6 x 16	11½
210	3 x 14 to 3 x 18	5½	800	8 x 8 to 8 x 14	13¼
280	4 x 6 to 4 x 10	5½	1000	10 x 10 to 10 x 12	16

For heavy mill construction work, the extra heavy steel wall hanger shown by No. 29 herewith is highly adaptable. It is provided with a plate that has eight inches of bearing on the wall and the bearing of the timbers on the hangers is also eight inches.

Wall hangers made from strap steel should not be used for heavy beams.

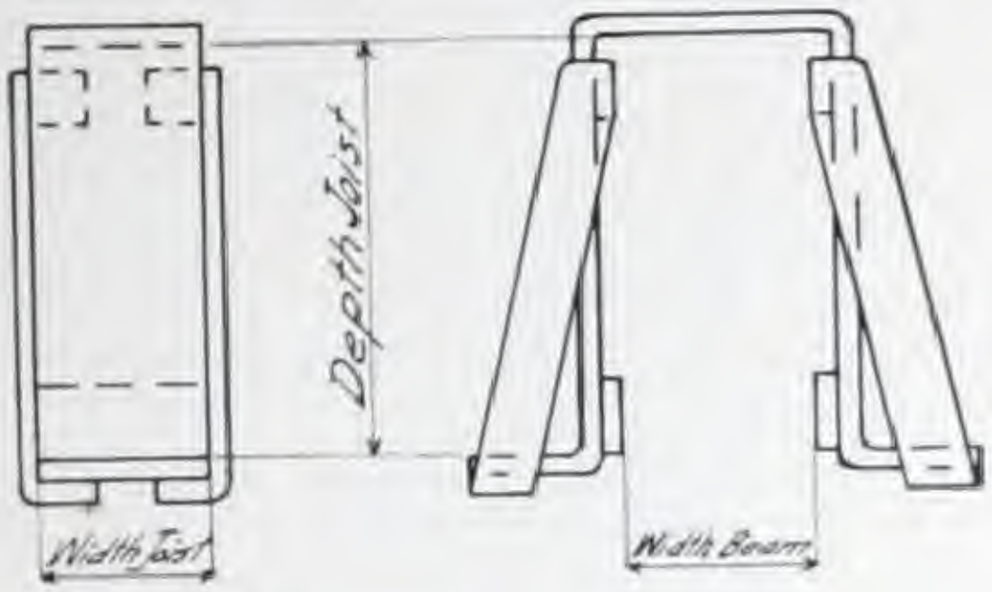
We carry all sizes of the extra heavy wall hanger in stock, the tables below show the size of joist carried by each size of wall hanger.

No. 29—*Extra Heavy Dupler Wall Hanger*

No.	Carries Joist, Size, In.	Shipping Weight, Lbs.	No.	Carries Joist, Size, In.	Shipping Weight, Lbs.
800	8 x 14 to 8 x 18	24	1400	14 x 14 to 14 x 18	53
1000	10 x 14 to 10 x 18	35	1600	16 x 16 to 16 x 20	68
1200	12 x 14 to 12 x 18	52			

WELDED HANGERS

The welded style of hanger combines strength and durability with economy in cost.

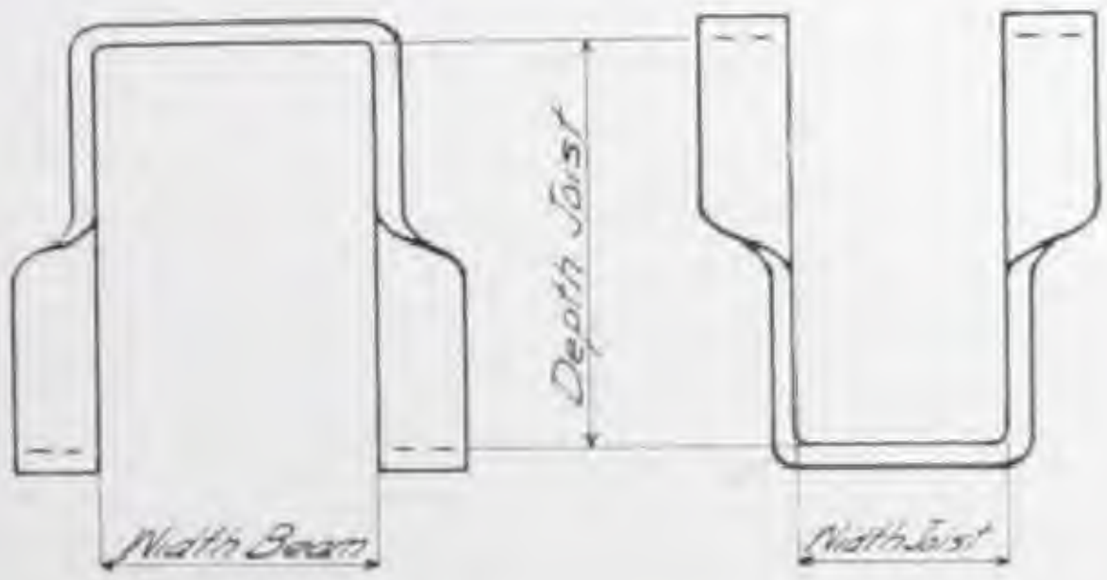


No. 30—Standard Welded Hanger

Welded hangers are made in all sizes, to suit dimensions of timber and thicknesses of material necessary for required loads.

STIRRUPS

Stirrups can be made up very quickly in our forge shop and orders for any number of any size can be executed promptly; we carry a large range of bar iron, flats and rounds from which these stirrups are made. Sometimes holes for lag screws or wire spikes for spiking stirrups to the timbers are wanted. Unless otherwise specified in the order we will always ship stirrups without holes.

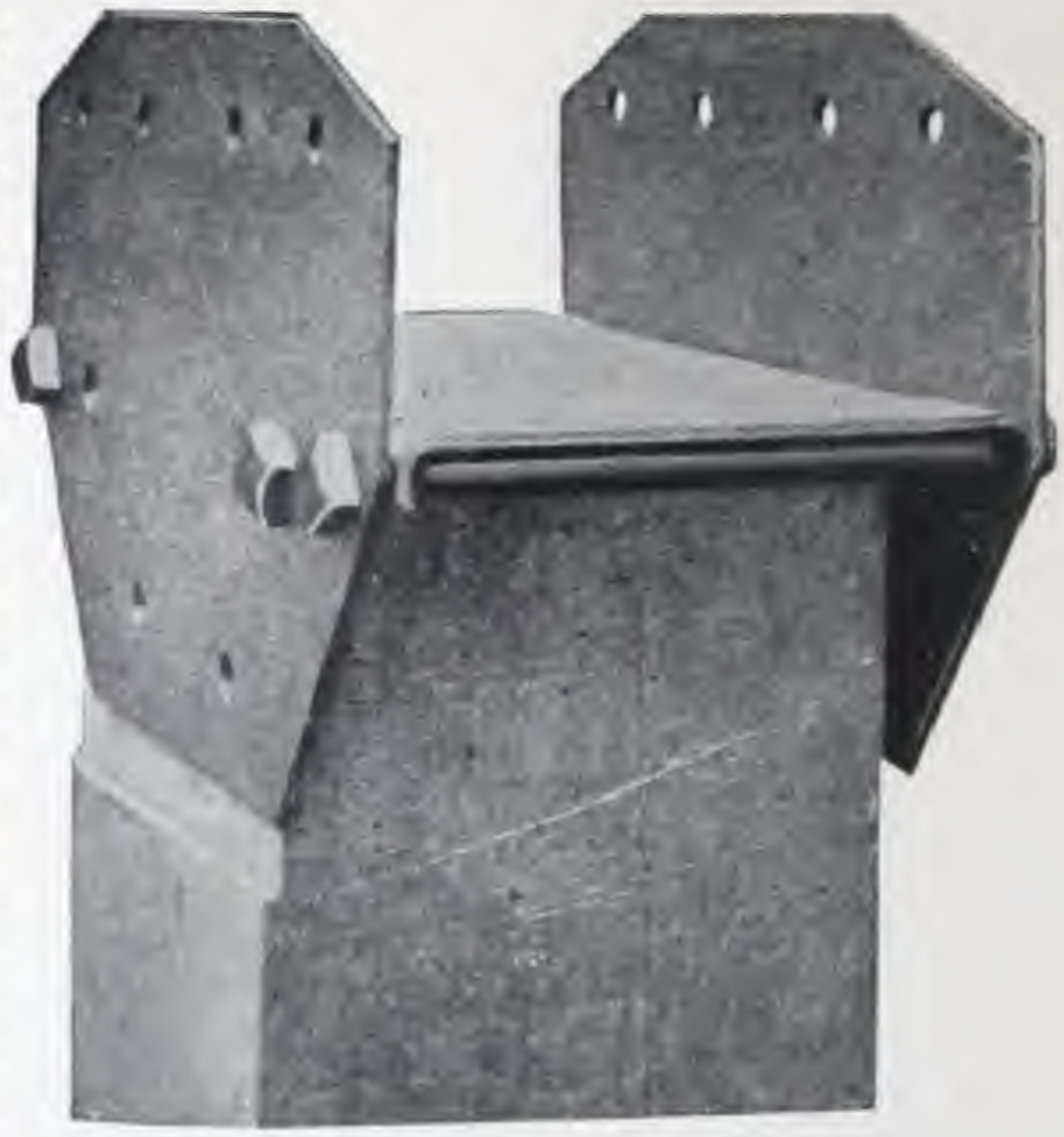


No. 31—Double Stirrup

Double stirrups are used when two beams or joists are to be framed to or carried by one girder or beam; single stirrups are required when one joist or beam is to be framed to or carried by a girder or beam. When ordering stirrups always state the width and depth of the carrying girder as well as the joists or beams to be carried; also state whether single or double stirrups are wanted. If size of iron is not given we will furnish the proper size for the timbers specified. Stirrups are usually made of flat bar iron as shown but may also be made of round iron, which would be somewhat less expensive but not so desirable.

POST CAPS

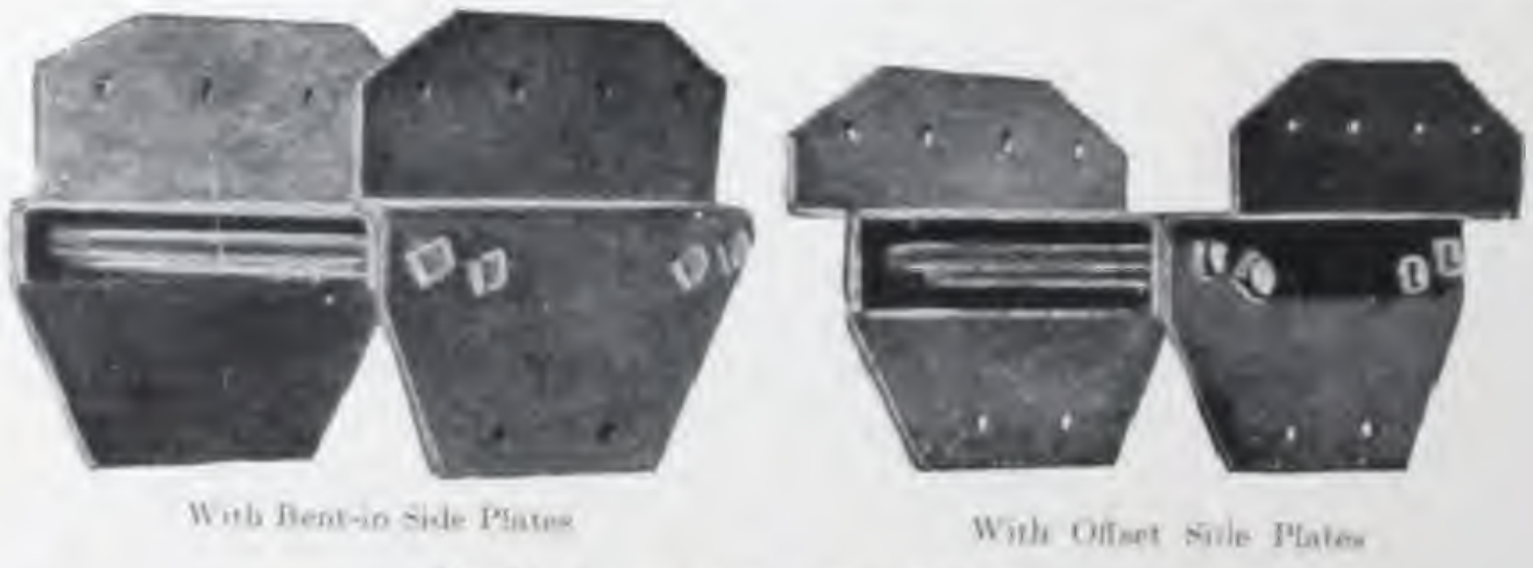
At the present time, there are a number of different types of post caps in general use, the best-known and most popular being the Duplex, illustrated herewith; we sell other styles, however, as requested. Ordinary sizes can be shipped from stock promptly.



No. 32—Two-Way Post Cap

The cap of the Duplex is made in three or more pieces of mild steel. For post caps up to 12-inch, ½-inch steel is used, and for heavier construction ⅝ or ¾-inch plates and bearing brackets are provided. The weight of the girder is carried on the shoulder formed on the post. The heavy bolts underneath the bearing brackets relieve the outer edge of the bracket and transmit the load directly to the post. The outer bolt is directly underneath the bearing bracket, while the inner bolt is close up against the post. The post cap is fastened to the post by lag screws forming a most rigid construction and virtually making a continuous post. The cap may be used for a continuous post by cutting the bearing brackets in the centre and notching the post to form a shoulder for the bearing bracket. These caps on account of their simple construction are readily made up to any desired detail and we illustrate a few of the stock sizes.

No. 32 represents the standard two-way cap while No. 33 shows a two-way post cap with bent-in side plates to accomodate a 10-inch girder with a 10 x 10 inch post above and a 12 x 12-inch post below, as well as a two-way cap with offset side plates to carry a 14-inch girder, with a 10 x 10-inch post below.



With Bent-in Side Plates

With Offset Side Plates

No. 33—Types of Two-Way Post Caps

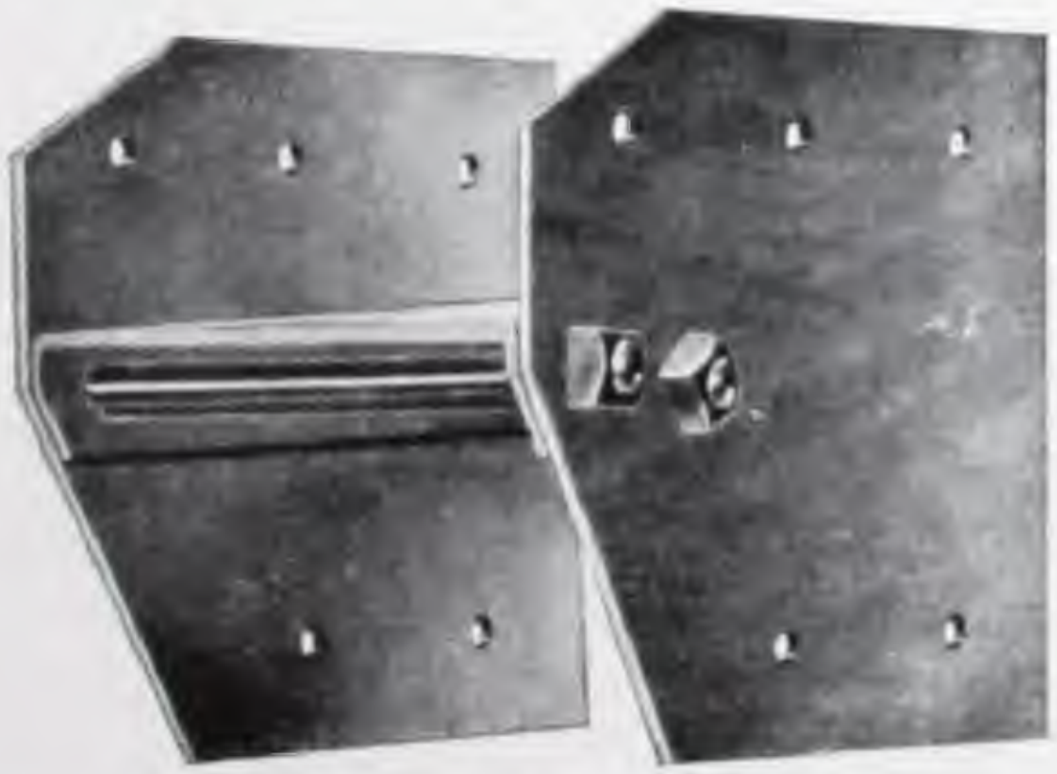
In addition to two-way post caps, three-, four- and one-way caps are used; the latter two styles are illustrated on the following page.

No. 34 represents a four-way post cap to carry four 10-inch girders on a 10 x 10-inch post. A different style of four-way cap is seen in illustration No. 35,

No. 34—Four-Way Post Cap

No. 35—Four-Way Post Cap, Offset

indicating a cap to carry two 14-inch girders and two 10-inch girders on a 10 x 10-inch post.



No. 36—One-Way Post Cap

The one-way cap is shown by No. 36 above, illustrated to carry one 12-inch girder on a 12-inch post.

Shipping Weights of Two-Way Duplex Post Caps

Size Post, In.	Size Girder, In.	Off-set, In.	Ship. Wt., Lbs.	Size Post, In.	Size Girder, In.	Off-set, In.	Ship. Wt., Lbs.	Size Post, In.	Size Girder, In.	Off-set, In.	Ship. Wt., Lbs.
6 x 6	6	0	30	10 x 10	12	1	57	14 x 14	18	2	140
6 x 6	8	1	31	10 x 10	14	2	69	16 x 16	16	0	155
6 x 6	10	2	34	12 x 12	12	0	72	16 x 16	18	1	160
8 x 8	8	0	35	12 x 12	14	1	76	16 x 16	20	2	168
8 x 8	10	1	36	12 x 12	16	2	84	18 x 18	18	0	190
8 x 8	12	2	40	14 x 14	14	0	124	20 x 20	20	0	220
10 x 10	10	0	52	14 x 14	16	1	132				

For three-way caps, add 25%. For four-way caps, add 50%. Bent-in caps should be estimated same as offset. Weights include bolts.

MISCELLANEOUS POST CAPS

Very serviceable and low priced post caps can be made up of standard channel, I-beam and angle sections as illustrated. The different parts are rivetted together as shown. Hundreds of them are sold for building construction in all parts of Western Canada. The angles form the post cap and the channel or I-beam carries the girder. Post caps of this description can be made of any size up to the limit of

Side View End View

No. 37—Steel Post Cap—Channel and Angles Riveted

Side View End View

No. 38—Steel Post Cap—I-Beam and Angles Riveted.

size of standard rolled sections of I-beams and channels. The angles are spiked to the post and the channel or I-beam is spiked to the girders. The girders should be securely fastened together lengthwise with iron straps or dogs. As we always carry a large stock of all sizes of I-beams, channels and angles, steel post caps of this kind can be made up very readily of any required size and shipped promptly. They are sold either at so much per 100 lbs. or at a stated price for any number required. Size of post and of girders should be given when writing for prices.

POST BASES

No. 10

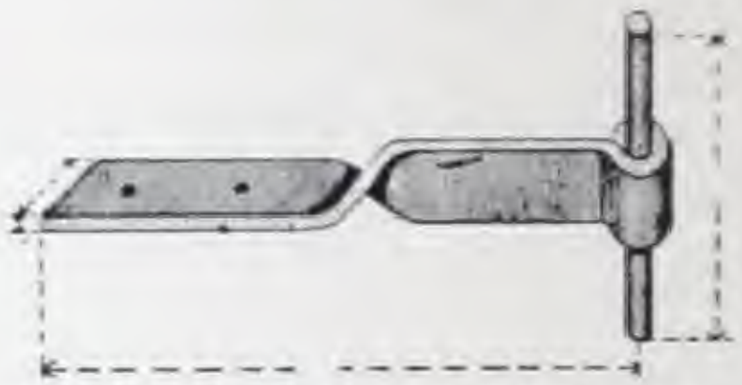
No. 11

JOIST ANCHORS AND BEAM TIES

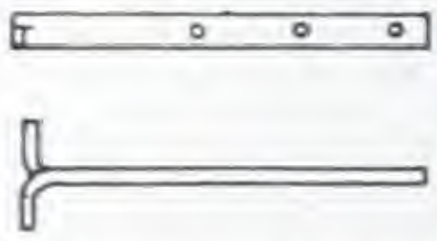
Several styles of joist anchors and dogs, beam anchors and ties are illustrated herewith. We can supply any style desired in these lines.

No. 41—Wrought Iron Joist Anchor with Round Face Plate.

No. 42—Wrought Iron Joist Anchor with Pin.



No. 43—Wrought Iron Joist Anchor with Pin



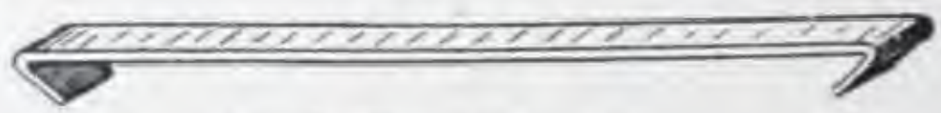
No. 44—Wrought Iron Joist Anchor with Split End.

No. 45—Wrought Iron Joist Anchor with Pin.

No. 41 shows a joist anchor for use on either side or top of joist. Nos. 42 and 43 are used fastened to side, and Nos. 44 and 45 fastened to top of joist.

No. 46—Wrought Iron Dog.

The wrought iron dog shown above is used for connecting joists or beams.



No. 47—Wrought Iron Tie

No. 48—Wrought Iron Pin Anchor

The tie and anchor illustrated above are for use with I-beams.

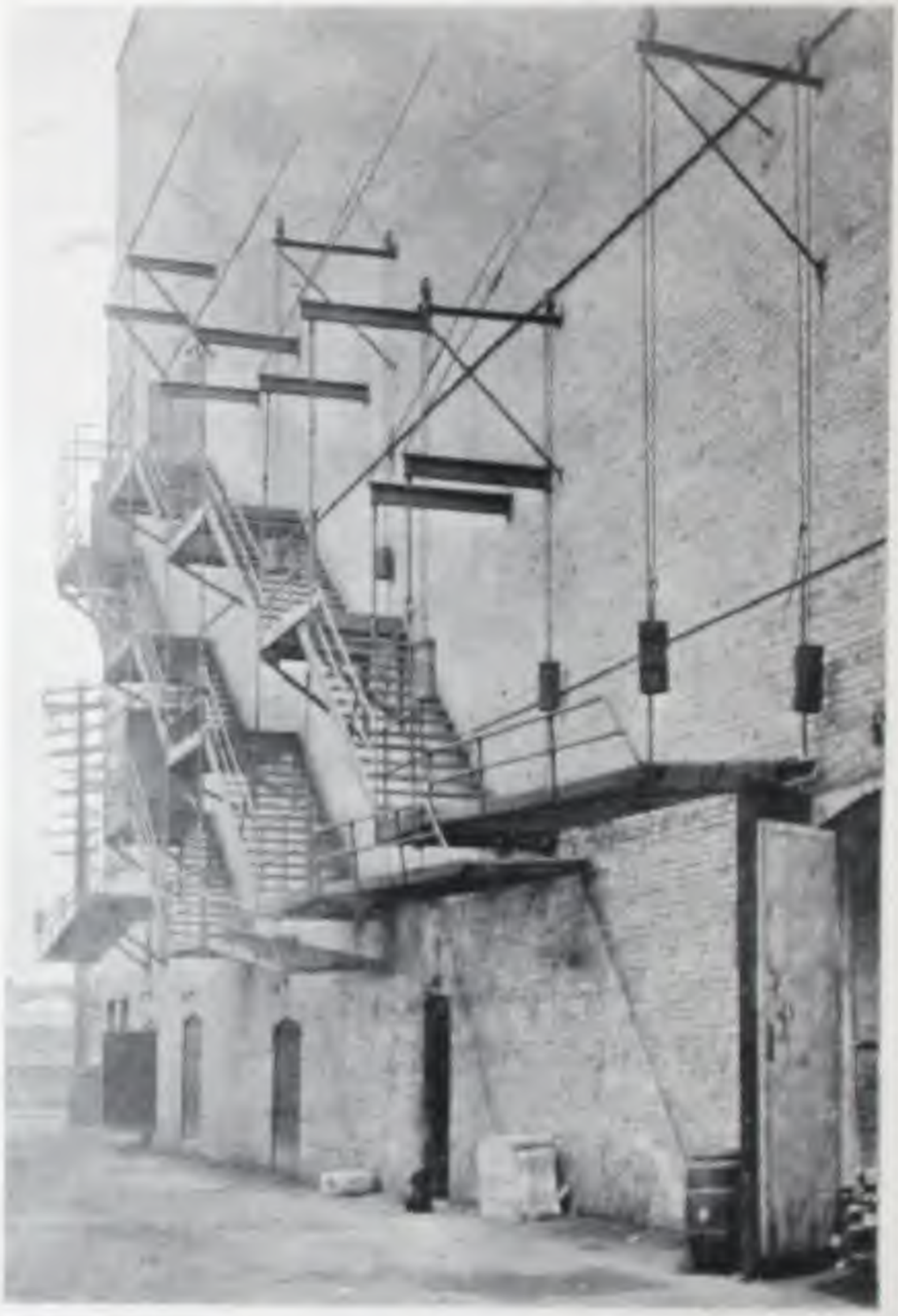
When ordering give dimensions, and number and size of holes wanted. Estimates for quanity orders will gladly be submitted.

BRIDGE BOLTS

No. 46

A — Eye screw.
B — Bridge bolt; square head and nut.
C — Square head, wedge point, drift spike.
D — Countersunk head, wedge point, drift spike.
E — Square sharp point, drift spike; without head.
F — Square flower pin.
G — Forged or cast spike.
H — Rugged drift spike, wedge point; without head.
I — Wire spike.
J — Round, sharp point, drift spike; without head.
M — Round flower pin.
N — Cast iron, flat screw or washer.
O — Malleable or pressed steel plate washer.
P — Cast iron bridge washer with taper hole for flat or round bolt with head nut.
Q — Irregular pattern cast iron bridge washer.
R — Square, oval, or angle or bent washer.
S — Square steel plate washer.
T — Round, cast iron, angle or bent washer.

NOTE.—In ordering from prices list state name under which bolt is known, its length, fashion, style of head and point, thickness of washer, size of hole, weight of nut, and whether washer is round or square.



No. 50.—View Enlarged at Head of Theatre, Showing Lowered Platform Screened with Counterweights.

Note.—When the weights other than those illustrated in this section are required, sketches and measurements showing how they are to be made up must be forwarded to us before we can quote prices or manufacture the weights.

FIRE ESCAPES

A modern fire escape consists of one or more balconies or landings securely fastened to the wall of a building opposite some convenient exit, either door or window, with a stairway so placed that the occupants of the building can reach the ground in safety from any balcony in case of fire. The fire escape, including stairs and ladder, should be constructed of steel, wrought iron or a combination of both. Fire escapes may be plain or as ornamental as required. In every case the balconies or landings, with their supporting brackets, should be strong enough to carry safely as many people as can be crowded on to them. It is customary to provide a ladder extending from the topmost balcony to the roof. At the lowest balcony a drop stairway is usually provided, which may be kept off the ground when not in use. Stairs with counterweights are shown by No. 50. The counterweight is enclosed in a pipe to prevent possibility of accident.

Our Standard Fire Escape, designed to conform to by-laws of the city of Winnipeg, is the most serviceable and least expensive on the market to-day. Several hundred have been sold during the past few years. The balconies consist of steel angle frame work with flat steel strap floor, carried on strongly-made steel brackets. Either ladder or stairs may be provided, as required. The ladders are well made, and if properly attached to wall will safely carry as many people as can get on them at one time. The stairs have steel channel or bar strings, with bar treads, no risers.

Balconies and stairs may have either angle railings or pipe railings. Angle railings are the least expensive and being made of steel will, if properly painted, last as long as any other kind. When fire escapes are ordered we will always furnish steel angle railings to both stairs and balconies unless otherwise instructed.

These fire escapes are shown by Nos. 50 and 51. We sell these standard fire escapes f.o.b. Winnipeg, made up with all fittings ready for erection.

When ordering or asking for prices on fire-escapes it is necessary for us to have the following information:

A—Length and width of balcony.

B—Whether angle or pipe railing is required.

C—Location of stair or ladder opening in floor or balcony; whether at right, left, or in centre.

D—Number of lineal feet of ladder.

E—Whether opening in floor for stand pipe is to be provided or not.

F—Whether ladder or stairs are required.

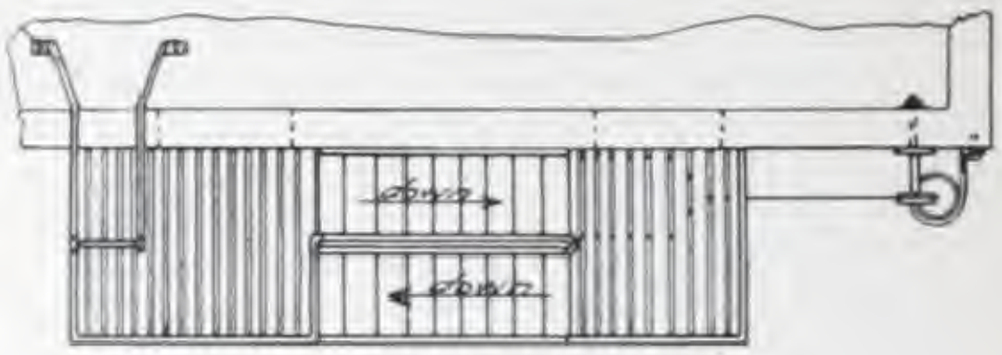
G—Whether ladder is to be attached to wall or to outside of frame work of balcony.

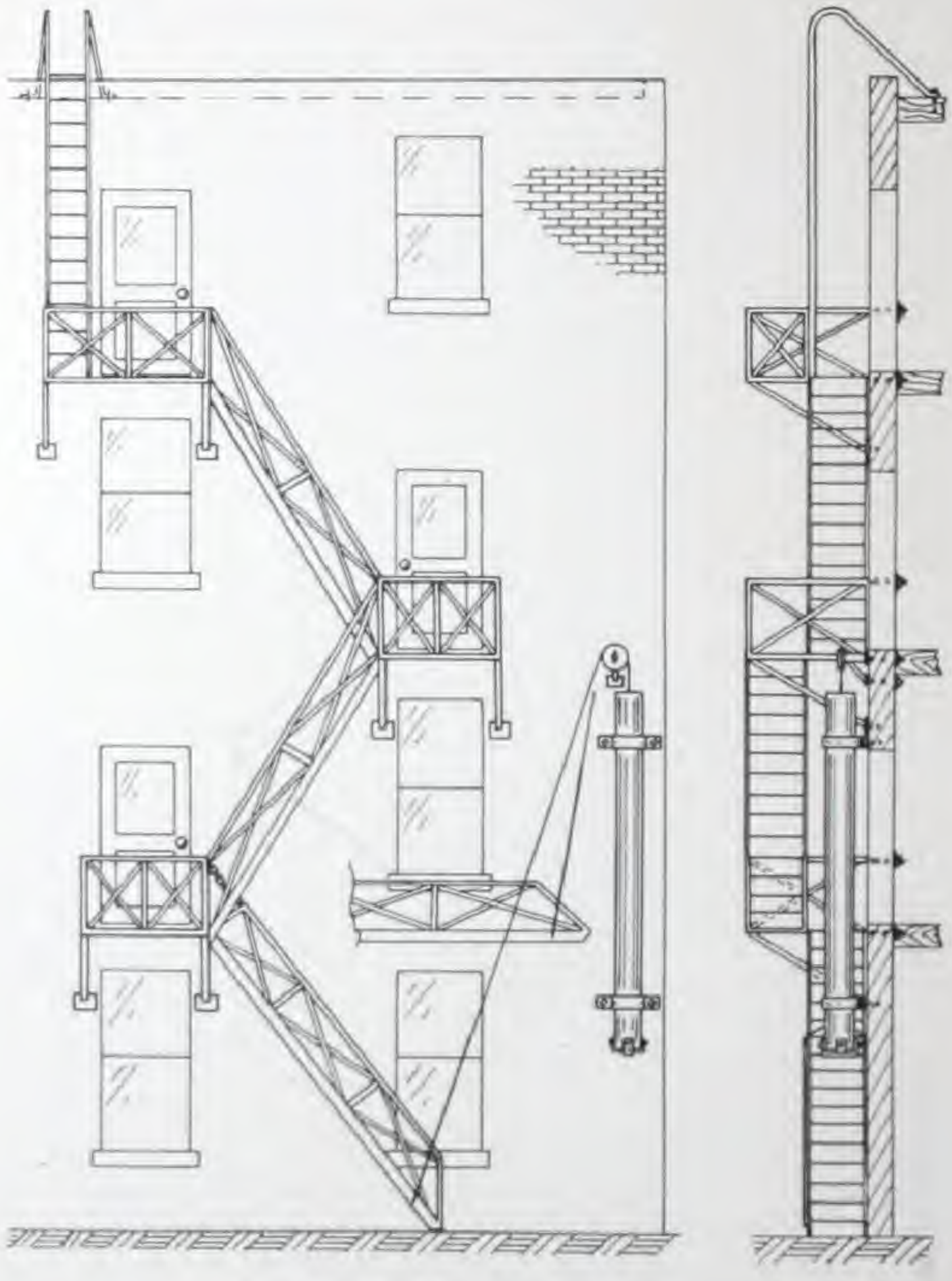
H—Thickness of wall at each landing, so that we may know what length to make the bracket bolts.

I—Width and height of parapet on roof, if any.

J—Projection and depth of cornice, if any.

K—If stairs are wanted, always give the "rise" and the "run". By "rise" we mean the vertical height from ground level to floor of lowest balcony or vertical height from the floor of each balcony to the floor of the one above. The "run" means the length of base of a triangle of which the stairs form the diagonal or longest side. Considering any flight or section of stairs, the stairs themselves would be one side (diagonal) of a triangle, the "rise" would be the vertical side and the "run" the base. These measurements should be given as correctly as possible to avoid mistakes.





No. 51—Standard Fire Escape, with Stairs

Specifications for this fire escape may be found on page 102.

CHUTE FIRE ESCAPES

No. 52—Chute Fire Escape

Chute fire escapes are used very commonly for country schools, their advantage over the ordinary stair type for children being obvious.

The illustration at the left, No. 52, illustrates a chute fire escape actually installed on a Manitoba school.

The top balcony is of the usual fire escape type, while the chute is constructed of twenty-gauge galvanized iron, rolled over a one-inch gas pipe and supported at intervals with flat bar brackets.

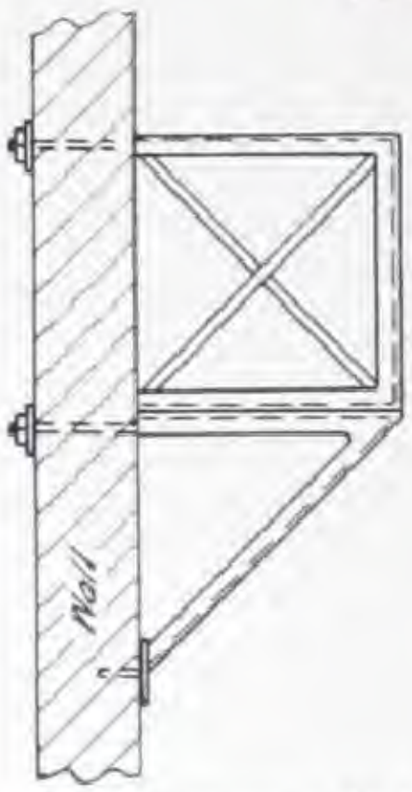
The inside of the chute and the rods are made perfectly smooth, and all corners are rounded.

The slope of the chute is usually 8 inches in 12 inches and at the bottom is a horizontal section about six feet long, two feet above the ground, being supported on four pipe standards. This straight section decreases the speed of the children sliding down and allows of adults standing at side to help the children clear of the escape as they come down.

Sometimes the bottom section of the escape is made with a hinged section and counter-weight as shown on the right in Illustration No. 53.

No. 53—Chute Escape with Counterweight

FIRE ESCAPE SPECIFICATIONS



No. 54—Showing End View of Balcony

STANDARD STYLE

Balcony

Steel angle frame-work; flat steel strap floor, rivetted.

Brackets

Steel angles and bolts through wall.

Ladders

Side bars, 1½ x ⅝-inch steel; rungs, ⅝-inch square bars.

No. 55—Detail of Standard Tread

Treads

Made of 1¼ x ¼-inch bars. The advantage of these treads is that no snow or ice will lodge in them; thus they are non-slip. This is the only type of tread now approved by by-laws for outside fire escapes.

CHUTE STYLE

Chute

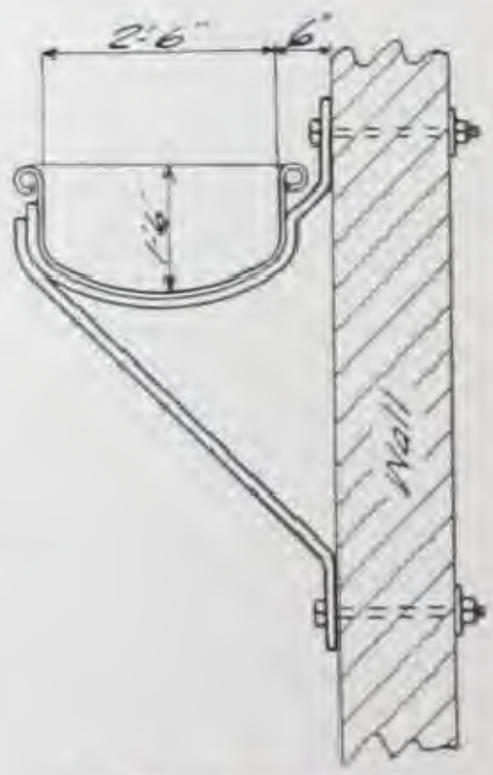
Galvanized iron construction, 20-gauge.

Brackets

Flat bars, 3 x ⅝-inch; ¾-inch bolts through walls.

Chute Beading

1-inch gas pipe with galvanized iron rolled over and soldered.

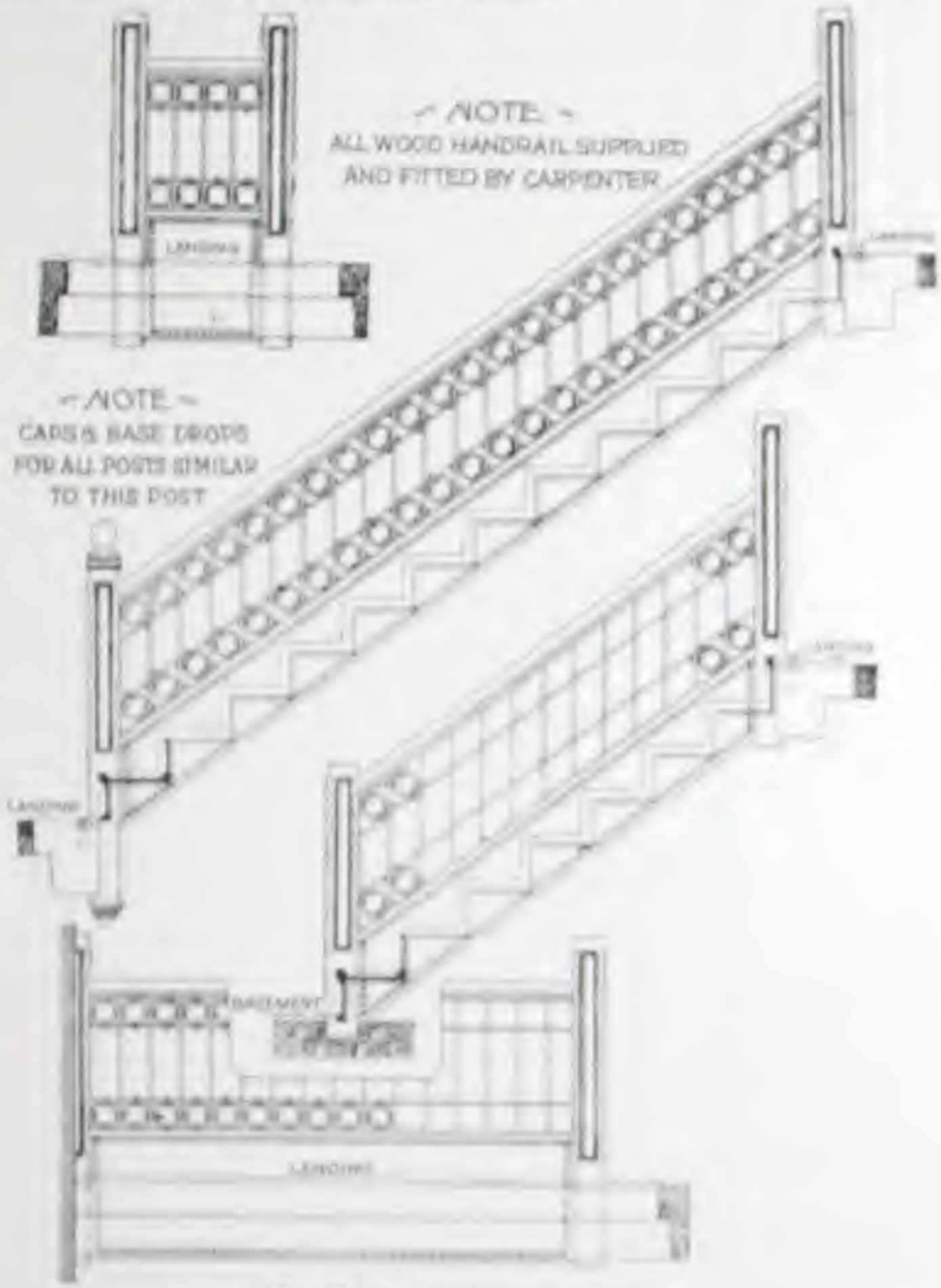


No. 56—Section of Chute Fire Escape

All fire escapes are assembled and properly fitted in our shops before shipment, and mistakes are not often made through any fault of ours. Workmanship is first-class.

STEEL AND IRON STAIRS

In municipal buildings, hotels, apartment houses, theatres, churches, office buildings, etc., interior stairways should be made of steel or iron or a combination of both, because of their fire resisting qualities.



No. 57 — Ornamental Iron Stairway

The design above illustrates our standard type of ornamental iron stairway. Posts or newels are cast iron, panelled. Strings, both wall and well, are cast iron or steel with exposed surfaces panelled; risers, well castings and risers are of cast iron or steel, with exposed surfaces panelled. Balustrade is wrought iron. As the treads are usually made of slate, stone or marble, metal treads are not furnished unless ordered.

Dimensions of standard stairways are as follows:

Width of stairs, 4 feet.
Width of tread, 10 inches.
Height of riser, 7 inches.
Height of balustrade, 27 inches.
Width of stringer, 12 inches.
Width of well casing, 12 inches (varies with thickness of floor).

SPIRAL STAIRS

Where space is limited and it is necessary to have means of communication between two or more floors, spiral stairs, made of pipe and cast iron, are often used.

No. 58—Interior Spiral Stairway.

The illustration on the left depicts one type of stairs we make.

The width of the stairs can be made anywhere from 36 inches to 72 inches, while the spiral may be right or left hand.

Landings can be provided anywhere, but, in this type of stairs, are usually limited in size to two treads, or in very exceptional cases, to three.

The center, or carrying post is made of standard wrought iron pipe, fitted with floor plate at bottom and ball cap at top.

Treads, in most cases, are corrugated cast iron, but can be made lead-filled cast iron, the cost in the latter case being much higher. Information concerning and description of lead-filled treads may be found on page 106.

The following information should be given when ordering:

A—Total height of stairs

B—Distance from finished floor to finished floor, each storey.

C—Whether post is to extend to ceiling; or, if not, how far above top landing.

D—Width or diameter of stairs.

E—Size of well or floor openings.

F—Whether spiral is right or left hand.

We have many other designs of spiral stairways besides that shown on the left; these designs will gladly be supplied to our customers without charge. We have patterns in stock which will enable us to make up these stairs within a few days after receiving order.

Shipping weights range from 44 to 120 lbs. per foot for spiral stairs from three to six feet in diameter.

IRON CRESTINGS

Iron crestings are used as decorative material for dark roofs, walls and copings. Besides the designs of crestings shown on this page, many other styles can be made up at reasonable cost. Curtain Rituals for any design are obtainable at small additional expense.

No. 59—Weight per lineal foot, 5.5 lbs.

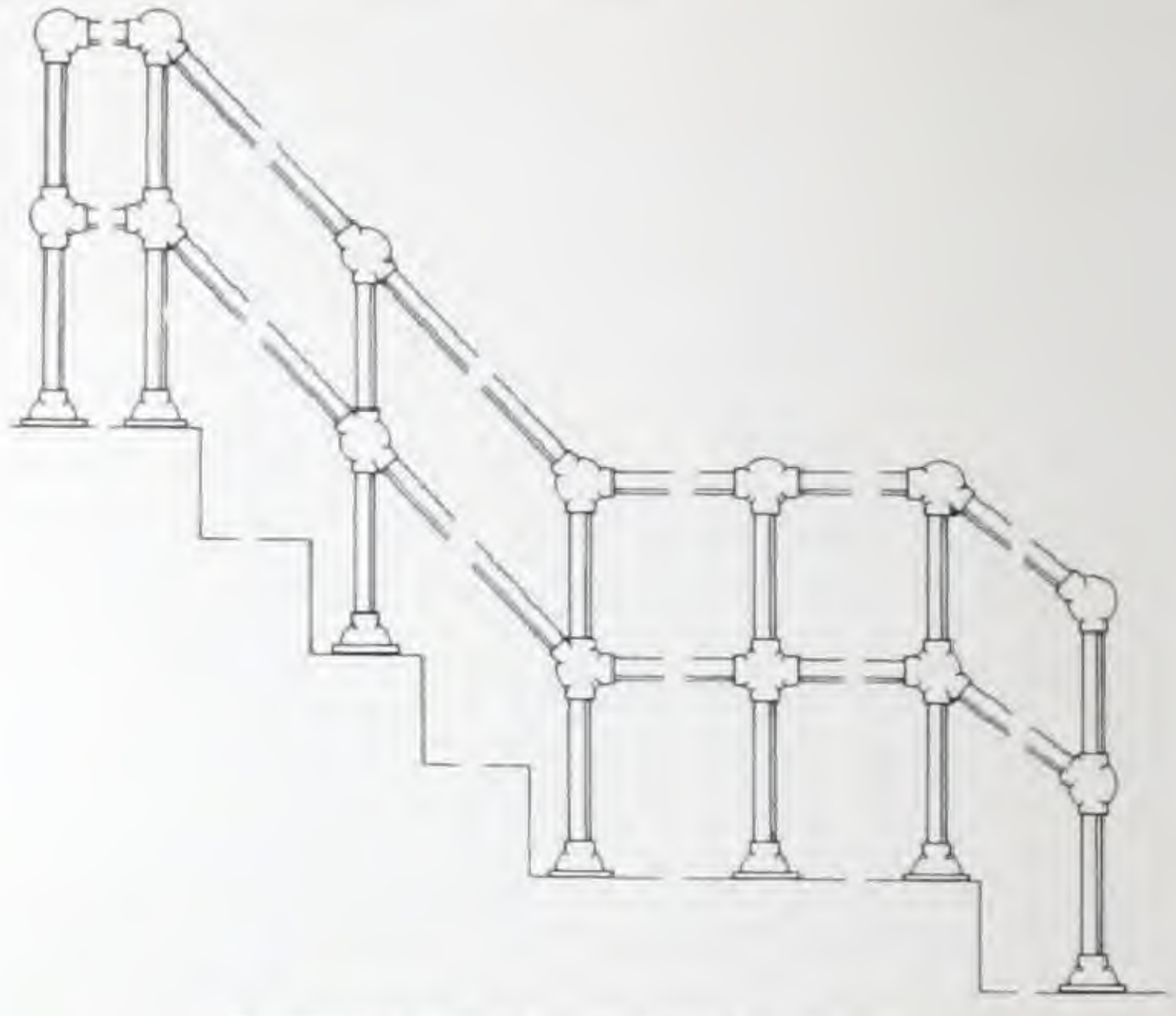
No. 60—Weight per lineal foot, 5 lbs.

No. 61—Weight per lineal foot, 7 lbs.

No. 62—Weight per lineal foot, 10 lbs.

PIPE RAILINGS

We make up pipe railings of all sizes for concrete stairs, area railings, etc. These are fitted up complete before shipping.

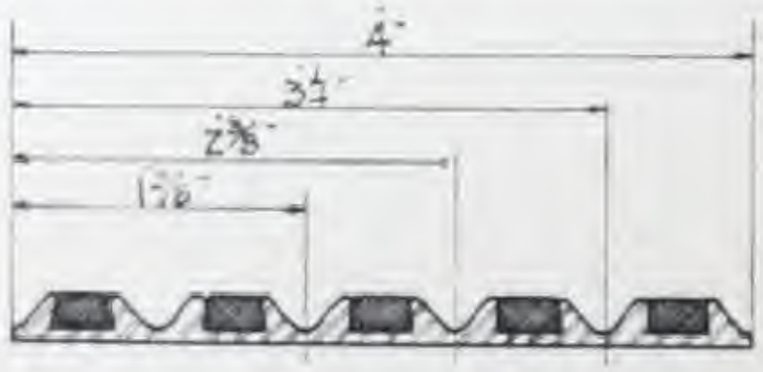


No. 63—Pipe Railing Equipped with Ball Fittings.

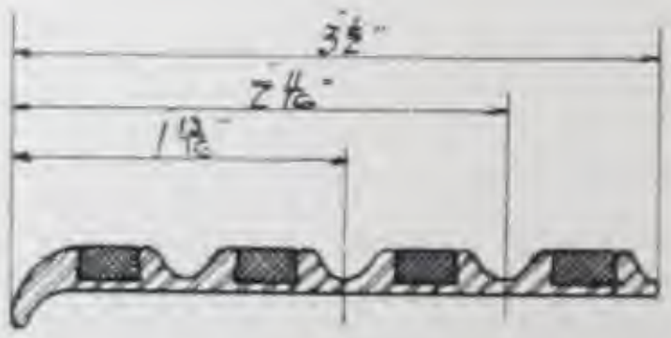
We use ball fittings in making up railings; the different angles of fittings are illustrated above. Our large variety of patterns enables us to furnish railings, fully fitted-up, that will cover all requirements and specifications.

SAFETY TREADS

Lead-filled safety treads for use on concrete steps can be supplied to customer's measurements. These treads are highly durable and afford secure footing in every

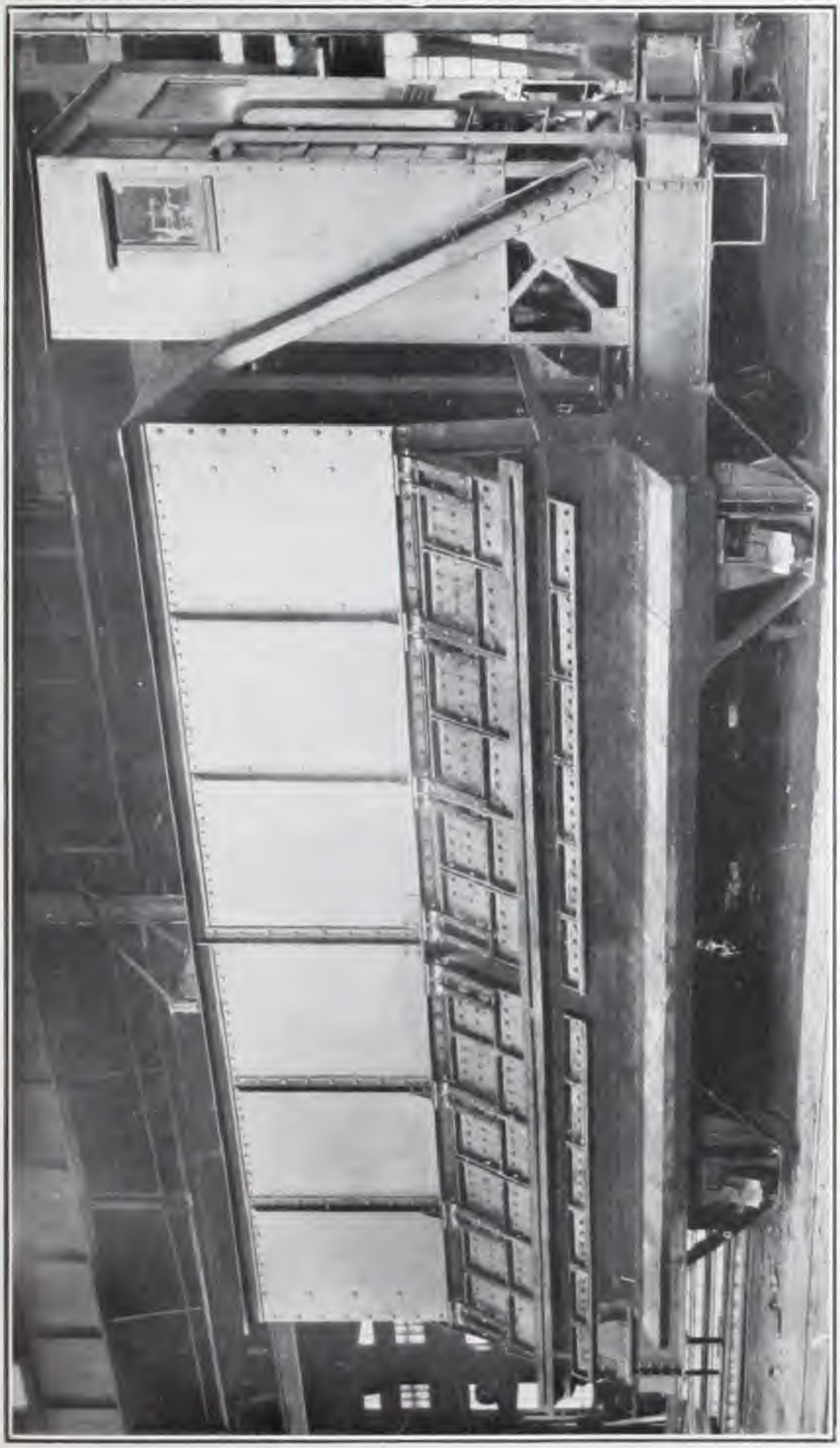


No. 64—Safety Tread



No. 65—Safety Tread with Nosing.

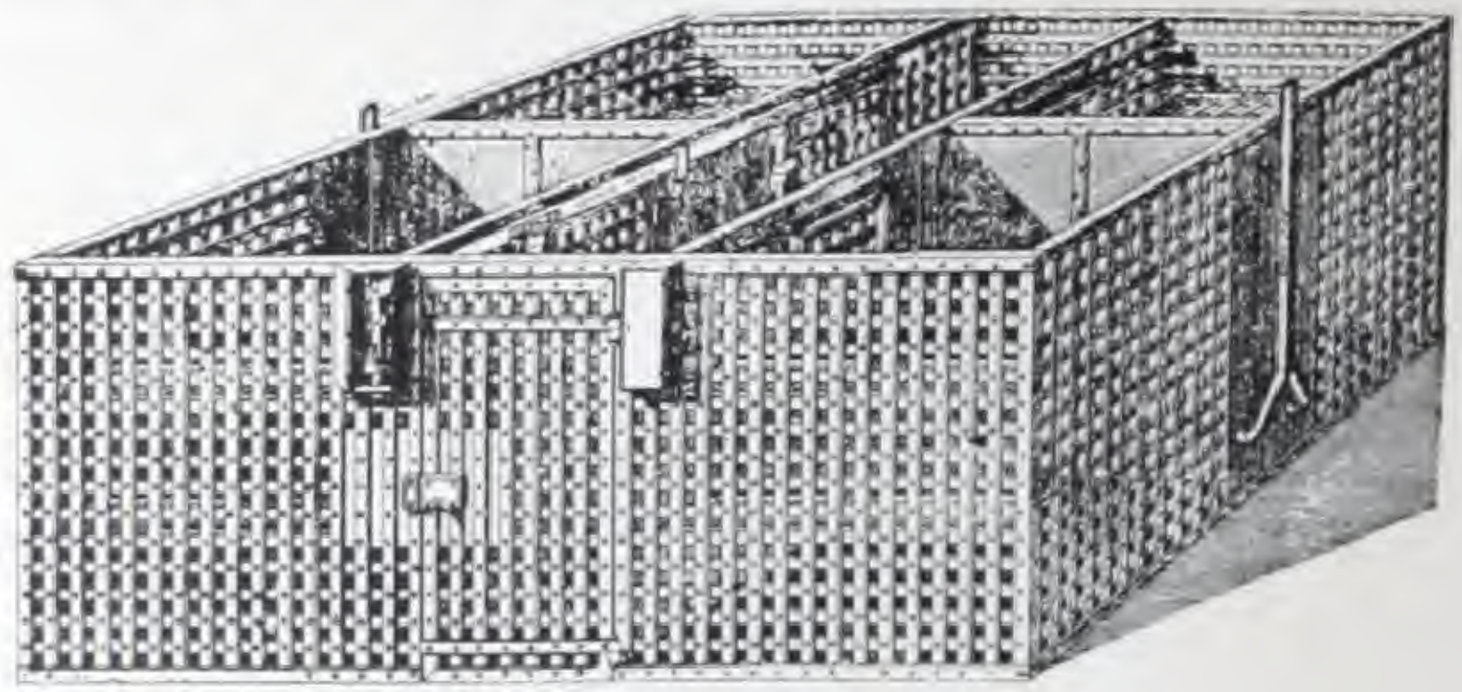
weather. They may be had in depths as indicated in the accompanying diagram, plain or with nosing.



No. 66.—Coke Quenching Car built by us for and to the design of the Atlas Car Co., Cleveland, Ohio, for the Winnipeg Electric Company.

JAIL EQUIPMENT

We will be pleased to enter into correspondence with towns, villages or municipal offices interested in jail and cell fittings.

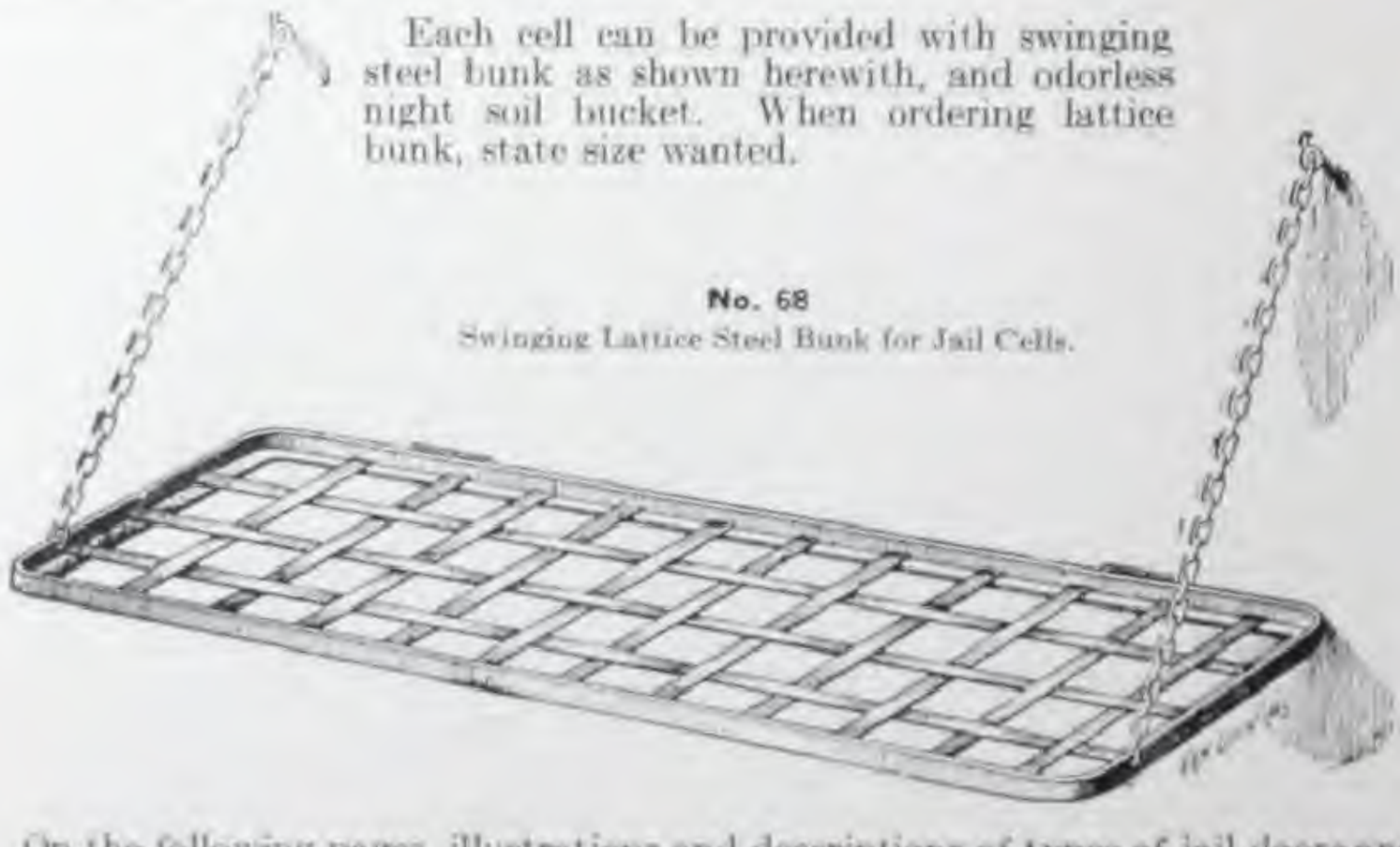


No. 67—Steel Lattice Jail Cells

Above is shown a block of four steel lattice cells with corridor. These cells are usually made of 1½ x ¼inch or 1½ x 3/16 inch steel bars, with spaces about 4½ inches square, securely riveted wth heavy rivets at all intersections. The frames are formed of 1¾ x 1¾ x 3/16 inch steel angles. Roof can be lattice work same as front, and sides of solid steel plate. Can be made with steel plate floor if desired or to attach to cement or wood floor. Partitions between cells are usually of steel plate lattice work facing corridor. Doors are fitted with improved locks, which afford ample security. All parts are fitted together complete at works before shipment and marked so that any ordinary mechanic can set up the cells without trouble.

We can furnish single cells or blocks of two, four, six or eight cells, with or without corridor. The lattice jail cell is the best medium priced cell made and has given satisfaction wherever installed.

Each cell can be provided with swinging steel bunk as shown herewith, and odorless night soil bucket. When ordering lattice bunk, state size wanted.



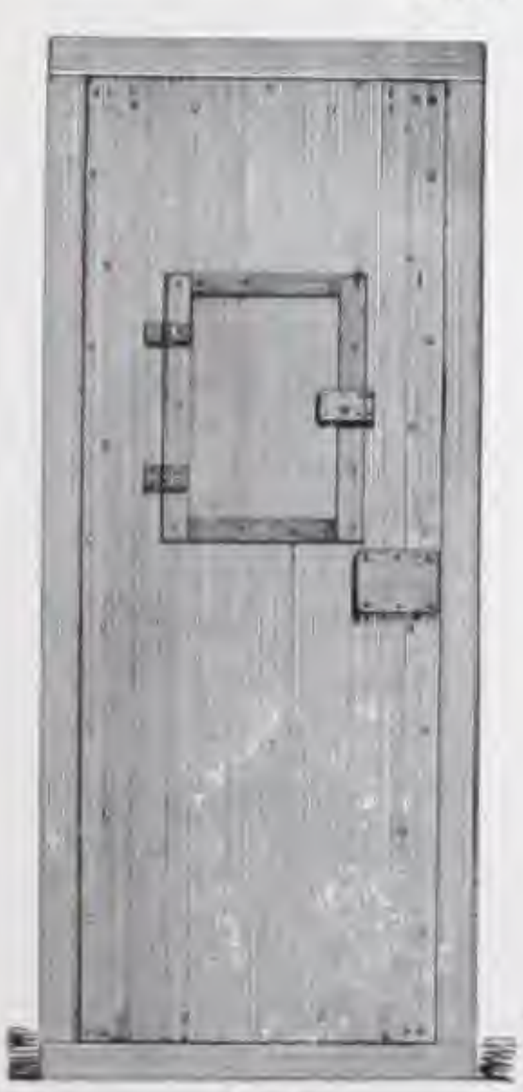
No. 68
Swinging Lattice Steel Bunk for Jail Cells.

On the following pages, illustrations and descriptions of types of jail doors and window-guards will be found. These doors can be constructed as part of the equipment for the jail cells shown above.

The illustrations on this page show jail doors of steel bar, lattice steel and steel plate construction—the styles of doors generally used for entrance to cell-room or jail building. They can be constructed heavier or lighter as occasion demands.

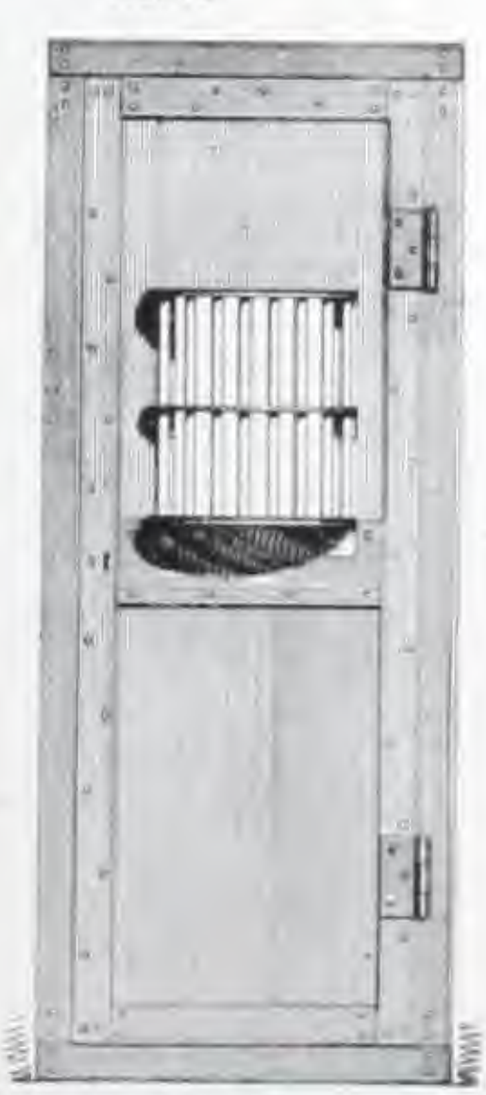
No. 69

No. 70



No. 71

No. 72



No. 73

No. 69, above, illustrates a steel bar jail door with round steel vertical bars, 1-inch diameter; horizontal bars 2 x $\frac{3}{16}$-inch; frame, 2 x $\frac{1}{4}$-inch; steel; outside frame heavy steel angle; forged hinges; heavy lock. This style of door can be made to fit any size of opening.

The heavy lattice steel door, No. 70, has steel bars $1\frac{1}{2}$ x $\frac{3}{16}$-inch; open space about $4\frac{1}{2}$ inches square; 2 x 2 x $\frac{1}{4}$-inch angle steel frames into which lattice is

riveted; forged hinges, steel armor plate around lock as shown; separate angle frame all around, usually wider and heavier than frame to lattice work of door.

Nos. 71, 72 and 73 are types of heavy steel plate jail doors made to fit any size of opening. Usually made of $\frac{1}{2}$-inch or $\frac{3}{4}$-inch steel plate securely riveted to 2 x 2 x $\frac{1}{4}$-inch steel angle frame, extra heavy, forged hinges, separate steel angle frame all around, usually wider and heavier than frame of door.

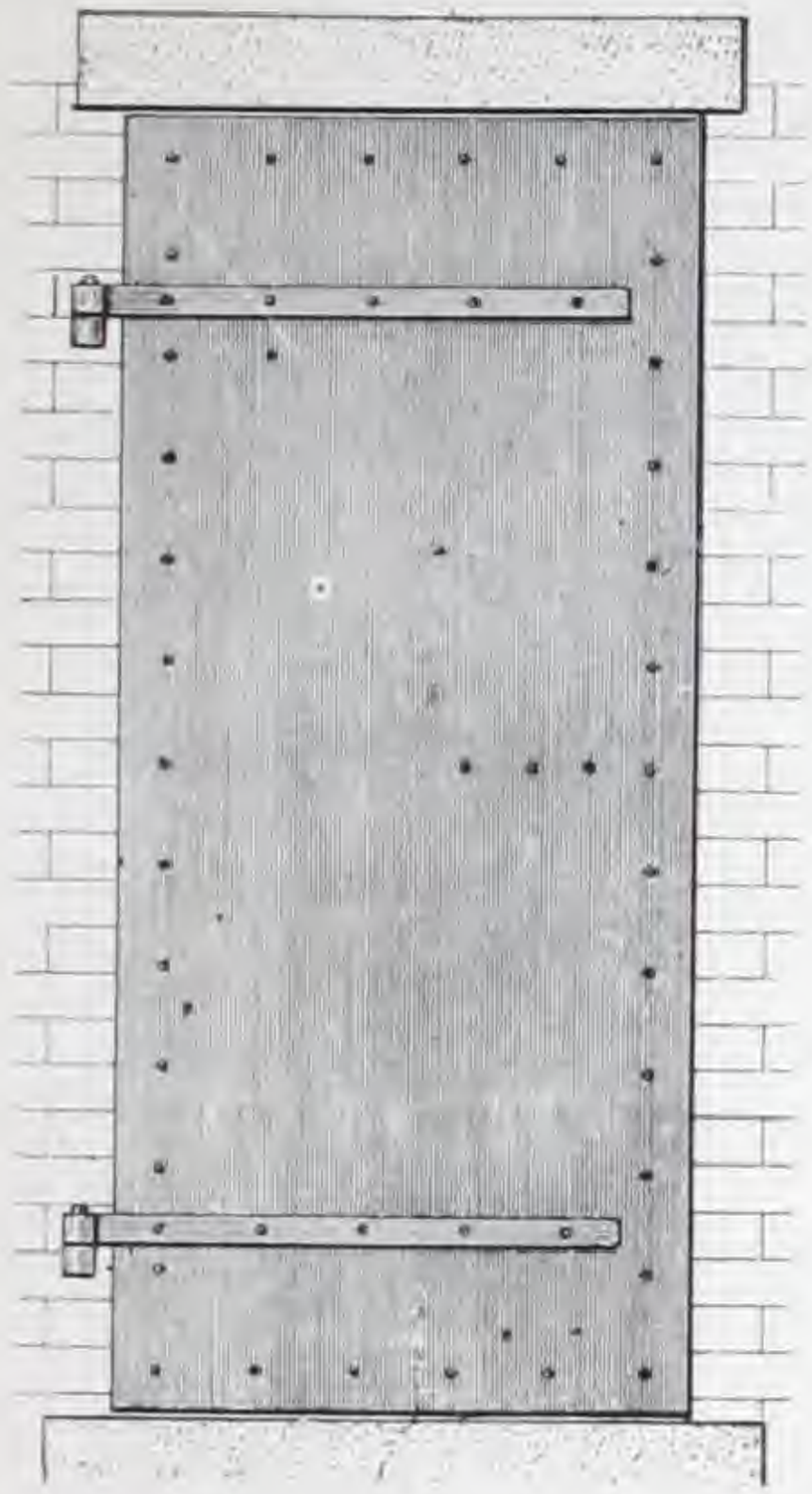
Steel plate doors can be fitted with observation grating as shown at No. 73, so jailer can see what is going on without opening doors.

No. 74

No. 75

We can supply window guards, in the styles illustrated above, to fit openings of any size. The guard shown in No. 74 is featured by round steel vertical bars set in heavy horizontal steel bars built securely into the wall, while No. 75 has square steel vertical bars set in heavy horizontal bars securely anchored in the wall. When ordering, give width and height of each clear opening.

Prices on any style of jail or cell fittings will gladly be quoted upon application.



STEEL DOORS AND FIRE SHUTTERS

Steel doors and fire shutters can be made up to any size and in any style. All work is securely rivetted and well finished.

No. 76 represents a sturdy and serviceable type of steel door.

When ordering or asking for prices, give all dimensions and thickness of plates also state if locking bars are wanted.

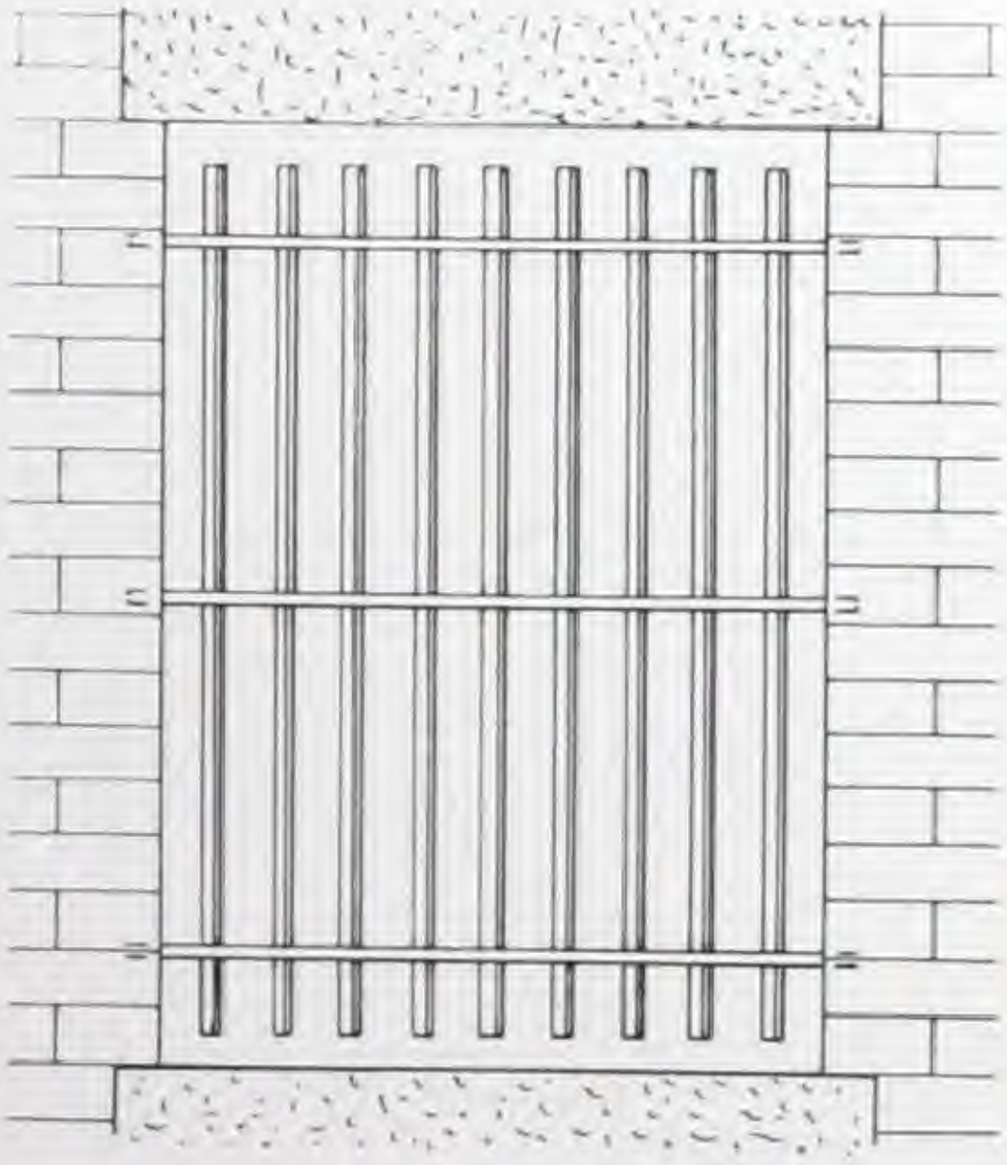
No. 76 (At Left)—Steel Door

WINDOW GUARDS

Steel window guards can be supplied to suit individual requirements.

In the illustration herewith, No. 77, a guard is shown constructed of 1-inch vertical round bars with 2 x ¼-inch horizontal bars.

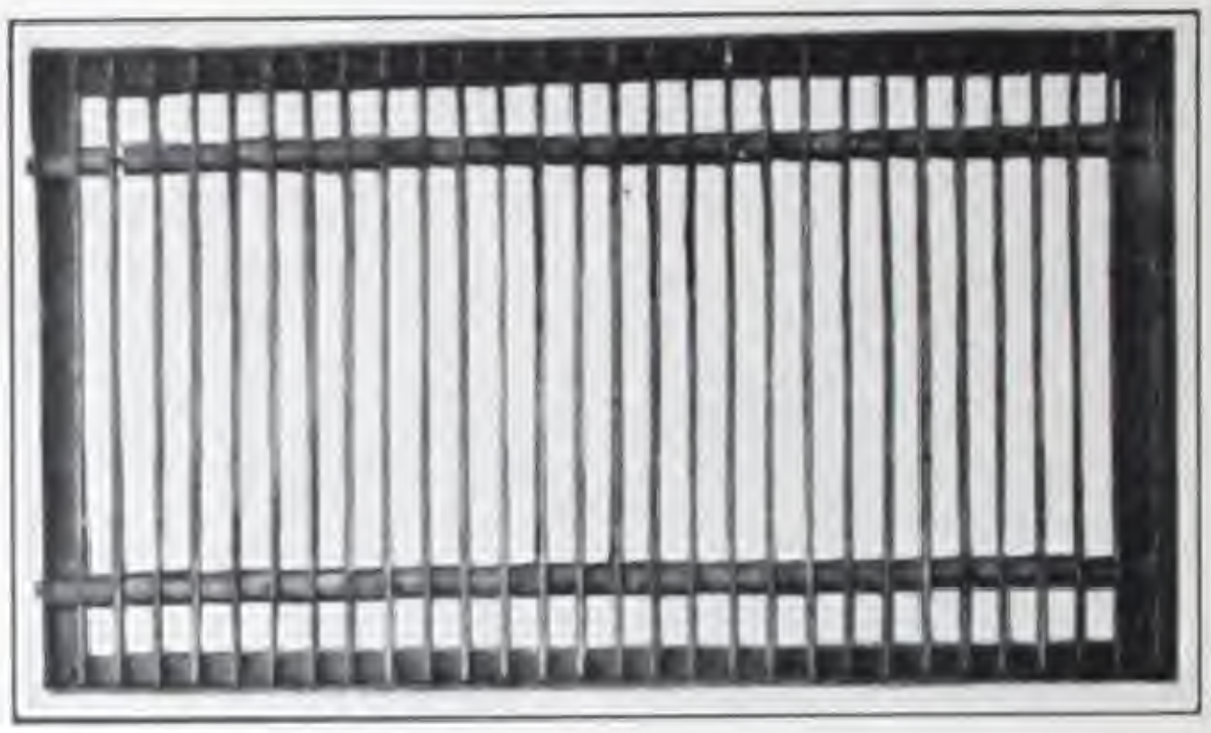
Give width and height of opening when ordering.



No. 77 (At Right)—
Steel Window Guard

AREA GRATINGS

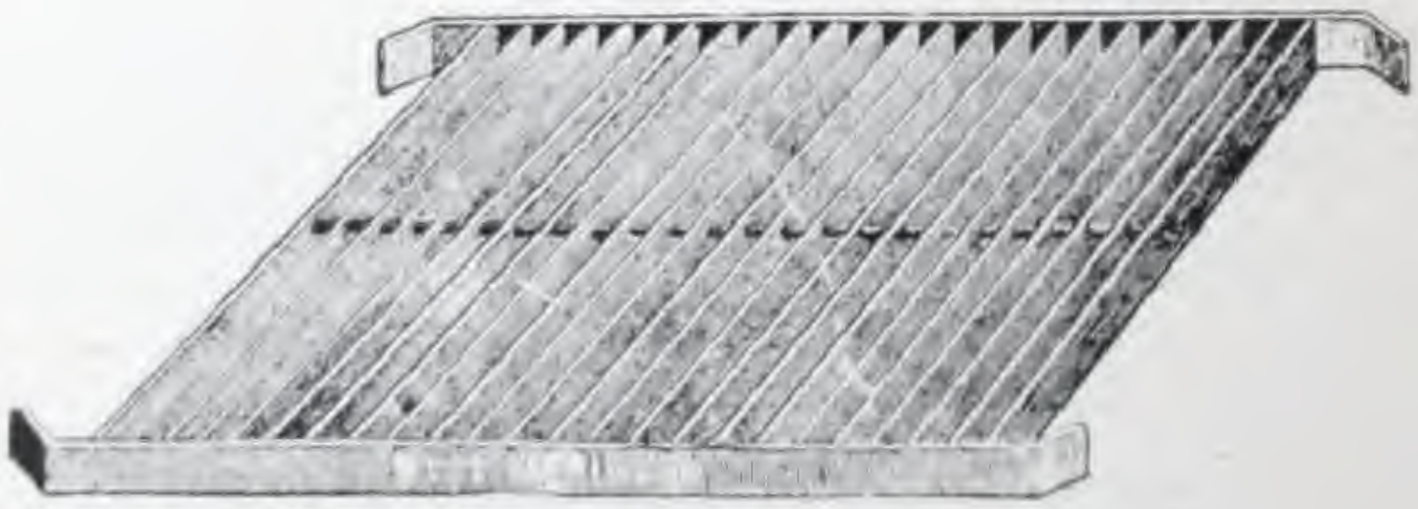
We are able to supply any size of any style of area grating on short notice as a large assortment of flats, rounds and angles are carried in stock for this work.



No. 78—Standard Area Grating.

Our standard side-walk area grating illustrated above, is made up of steel angle frame $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$-inch, riveted at corners; $1\frac{1}{4} \times \frac{1}{4}$-inch flat bars on edge, spaced at $1\frac{1}{2}$-inch centers with cast iron separators on $\frac{3}{4}$-inch round iron rods or bolts. Two of these rods are furnished when grating is three feet or less in width, and when over three feet wide, three or more bolts are used. Weight per square foot, out to out measurements, 14 lbs.

When ordering standard area grating, give length and width overall, allowing 2-inch bearing on all sides; specify whether or not angle frame is desired.



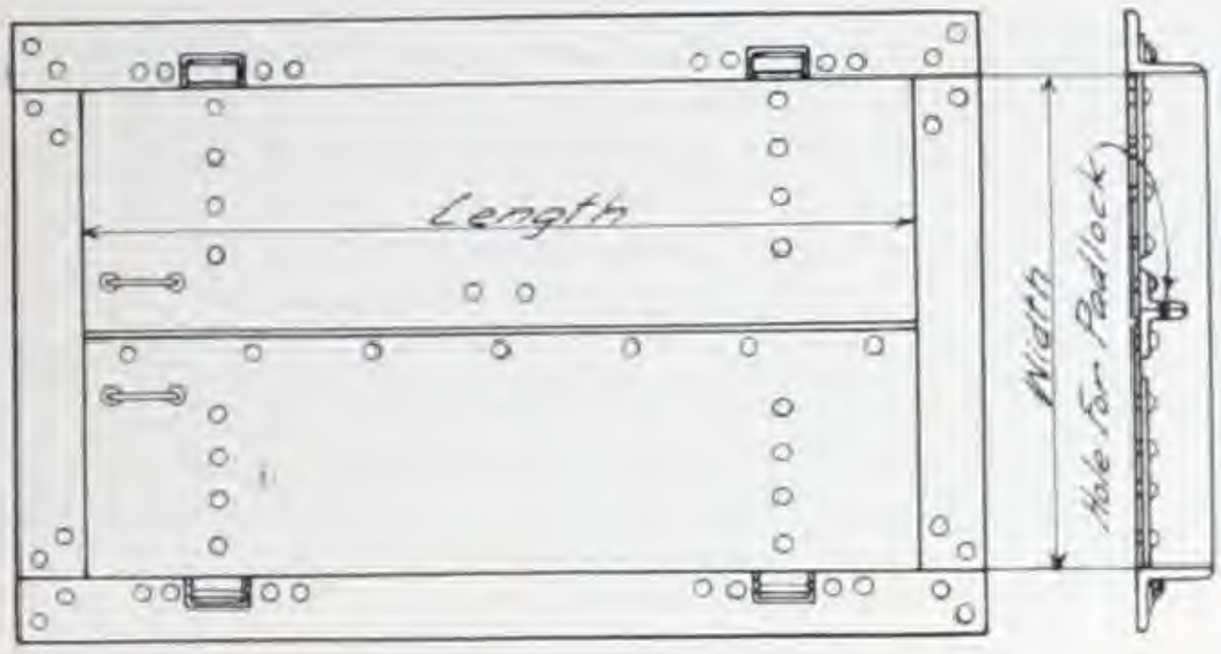
No. 79—Area Grating

Another type of grating is illustrated by No. 79. It is made up of wrought iron slats, fastened to frame at ends; stiffening rod in center.

In writing for prices and discounts, state sizes required and style desired.

SIDEWALK DOORS

Our standard sidewalk door is strongly made and will carry any load likely to be placed on it. It is made of solid steel plates in angle frames, with locking attachment.

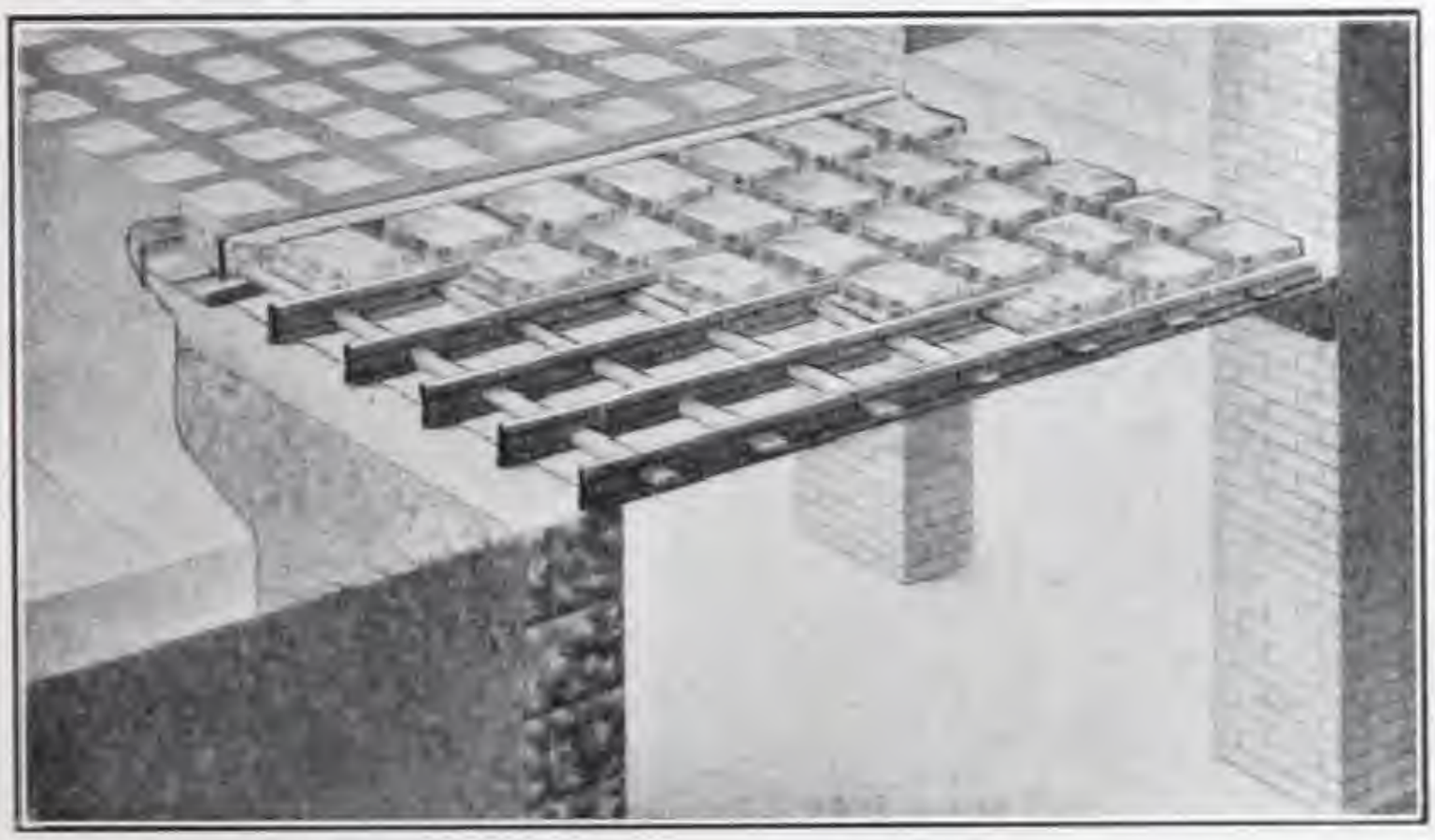


No. 80—Standard Sidewalk Door

Sizes out to out of openings should be specified in orders or requests for estimate; also whether doors are to be in one or two pieces or leaves.

SIDEWALK LIGHTS

Space under a building and adjacent side walk may be made useful by means of sidewalk lights, as shown in the illustration below.



No. 81—Showing the Use of Sidewalk Lights

The lights are carried on wrought steel framework and imbedded in cement, watertight. A bearing of about two inches on the building side and of about the same area on the wall side should be provided; bearing should be 2¼ inches below finish level.

STANDARD WATER STORAGE TANKS

Our standard water storage tanks are tested to 100 pounds hydrostatic pressure and are guaranteed for a working pressure not exceeding 65 pounds per square inch.

No. 82—Standard Water Storage Tank.

Heads are dished to a radius equal to the diameter of the shell; 20-in. to 36-in. diameter tanks are welded throughout; 42-in. diameter tanks have longitudinal and girth seams riveted, and heads welded.

Tanks can be furnished with manhole or handhole if required. Coils for hot water tanks, see page 116.

Six standard openings as shown above, are included. For larger or smaller openings or for openings located differently than shown, prices will be quoted on request.

Manufacturers' Standard List

Size		Thickness of Material			Regular Openings, Inches	Approximate Capacity		Approx. Weight Lbs.	List Price Black
Dia. in Inches	Length in Feet	Shell	Convex Head	Concave Head		Imp. Gals.	U.S. Gals.		
20	4	3/16	1/4	1/4	1 1/2	55	66	250	$ 94.00
20	5	3/16	1/4	1/4	1 1/2	70	85	295	104.00
24	4	3/16	1/4	1/4	1 1/2	80	100	310	109.00
24	5	3/16	1/4	1/4	1 1/2	100	120	360	123.00
24	6	1/4	1/4	1/4	1 1/2	120	140	410	134.00
30	4	1/4	1/4	1/4	2	125	150	395	143.00
30	5	1/4	1/4	1/4	2	155	180	455	158.00
30	6	1/4	1/4	1/4	2	185	220	515	173.00
30	7	1/4	1/4	1/4	2	215	250	585	196.00
30	8	1/4	1/4	1/4	2	245	295	645	211.00
36	6	1/4	1/4	1/4	2	265	315	685	206.00
36	7	1/4	1/4	1/4	2	310	365	760	241.00
36	8	1/4	1/4	1/4	2	350	420	835	256.00
36	10	1/4	1/4	1/4	2	440	525	980	293.00
42	6	1/4	5/16	1/4	2	360	430	835	276.00
42	7	1/4	1/4	1/4	2	420	500	940	310.00
42	8	1/4	1/4	1/4	2	480	575	1025	333.00
42	10	1/4	1/4	1/4	2	600	720	1250	375.00
42	12	1/4	1/4	1/4	2	720	865	1430	415.00
42	14	1/4	1/4	1/4		840	1000	1620	468.00

Larger sizes than those listed above, quoted upon application. We have a well equipped galvanizing department. Prices for galvanized tanks quoted upon application.

EXTRA HEAVY WATER STORAGE TANKS

Our extra heavy water storage tanks are tested to 150 pounds hydrostatic pressure, and are guaranteed for a working pressure not exceeding 100 pounds per square inch.

No. 82—Extra Heavy Water Storage Tank

Heads are dished to a radius equal to the diameter of the shell; 24-in. diameter tanks are welded throughout; 30-in. and 36-in. diameter tanks have longitudinal and girth seams rivetted, and heads welded; 42 in. and 48 in. diameter tanks are rivetted throughout. Tanks can be furnished with manhole or handhole if required. Coils for hot water tanks, see page 116.

Six standard openings as shown above, are included. For larger or smaller openings or for openings located differently than shown, prices will be furnished on request.

Manufacturers' Standard Specifications

Size		Thickness of Material			Regular Openings, Inches	Approximate Capacity		Approx. Weight Lbs.	List Price, Black
Dia. in Inches	Length in Feet	Shell	Convex Head	Concave Head		Imp. Gals.	U.S. Gals.		
24	5	3/16	1/4	1/4	1 1/2	100	120	360	$137.00
24	6	3/16	1/4	1/4	1 1/2	120	140	410	155.00
30	5	3/16	1/4	5/16	2	155	180	480	182.00
30	6	3/16	1/4	5/16	2	185	220	545	198.00
30	7	3/16	1/4	5/16	2	215	250	615	224.00
30	8	3/16	1/4	5/16	2	245	295	680	242.00
36	6	1/4	5/16	3/8	2	265	315	890	264.00
36	7	1/4	5/16	3/8	2	310	365	990	300.00
36	8	1/4	5/16	3/8	2	350	420	1090	328.00
36	10	1/4	5/16	3/8	2	440	525	1200	385.00
42	6	1/4	3/8	7/16	2	360	430	1160	345.00
42	7	1/4	3/8	7/16	2	420	500	1280	390.00
42	8	1/4	3/8	7/16	2	480	575	1430	420.00
42	10	1/4	3/8	7/16	2	600	720	1540	480.00
42	12	1/4	3/8	7/16	2	720	865	1940	540.00
42	14	1/4	3/8	7/16	2	840	1000	2180	514.00
48	8	3/16	7/16	1/2	2	625	750	1760	510.00
48	10	3/16	7/16	1/2	2	785	940	2030	580.00
48	12	3/16	7/16	1/2	2	940	1130	2340	650.00
48	14	3/16	7/16	1/2	2	1125	1300	2610	715.00
48	16	3/16	7/16	1/2	2	1250	1500	2880	800.00
48	18	3/16	7/16	1/2	2	1415	1700	3150	870.00

Larger sizes than those listed above, quoted upon application. We have a well equipped galvanizing department. Prices for galvanized tanks quoted upon application.

STEAM COILS

The illustration below shows the arrangement of horizontal steam coils in standard or extra heavy water storage tanks.

No. 84—Steam Coil Arrangement

LIST PRICES OF HORIZONTAL STEAM COILS, BUILT IN TANKS.

Size of Tank	Size of Coil	Price of Plain Coil	Price of Galvanized Coil
20" x 4'	4 Pipes 1 inch	$29.00	$35.00
20" x 5'	4 " 1 "	30.50	38.50
24" x 4'	4 " 1¼ "	35.50	42.00
24" x 5'	4 " 1¼ "	37.00	45.00
24" x 6'	4 " 1¼ "	38.50	48.00
30" x 4'	4 " 1¼ "	35.50	42.00
30" x 5'	4 " 1¼ "	37.00	45.00
30" x 6'	4 " 1¼ "	38.50	48.00
30" x 7'	4 " 1¼ "	40.00	51.00
30" x 8'	4 " 1¼ "	41.50	54.00
36" x 6'	4 " 1½ "	51.00	62.00
36" x 7'	4 " 1½ "	54.00	66.00
36" x 8'	4 " 1½ "	57.50	70.00
36" x 10'	4 " 1½ "	64.00	78.00
42" x 6'	4 " 1½ "	51.00	62.00
42" x 7'	4 " 1½ "	54.50	66.00
42" x 8'	4 " 1½ "	57.50	70.00
42" x 10'	4 " 1½ "	64.00	78.00
42" x 12'	4 " 1½ "	70.50	85.00
42" x 14'	4 " 1½ "	77.00	93.00

Prices on brass, copper and spiral coils for tanks quoted on application.

Our Tank Catalogue

which treats in a more detailed manner, of this branch of our activities, will be gladly supplied on request. A post-card directed to our Winnipeg office will bring one of these books to you immediately.

HYDRO PNEUMATIC PRESSURE TANKS

Our hydro pneumatic pressure tanks are tested to 125 pounds hydrostatic pressure, and are guaranteed for a working pressure not exceeding 75 pounds per square inch.

No. 85—*Hydro Pneumatic Pressure Tank*

Heads are dished to a radius equal to the diameter of the shell; 24-in., 30-in. and 36-in. diameter tanks are welded throughout; 42 in. and 48 in. diameter tanks are rivetted throughout. All tanks are furnished with 3 standard openings in shell for 1¼- in. pipe, 2½-in. openings in shell and 2½-in. openings in concave head for water glass fittings, so that tank can be used either vertically or horizontally. Tanks can be furnished with manhole or handhole if required.

For larger or smaller openings, or for openings located differently than shown, prices will be furnished on request.

MANUFACTURERS' STANDARD LIST
HORIZONTAL OR VERTICAL

Size		Thickness of Material			Approximate Capacity		Approx. Weight Lbs.	List Price, Black
Dia. in Inches	Length in Feet	Shell	Convex Head	Concave Head	Imp. Gals.	U.S. Gals.		
24	5	5/16	1/4	1/4	100	120	335	$120.00
24	6	5/16	1/4	1/4	120	140	390	135.00
24	10	5/16	1/4	1/4	200	235	600	204.00
30	6	5/16	5/16	5/16	185	220	545	172.00
30	8	5/16	5/16	5/16	245	295	675	212.00
30	10	5/16	5/16	5/16	305	365	800	244.00
36	6	5/16	5/16	5/16	265	315	675	205.00
36	8	5/16	5/16	5/16	350	420	840	255.00
36	10	5/16	5/16	5/16	440	525	985	295.00
36	12	5/16	5/16	5/16	530	630	1130	330.00
36	14	5/16	5/16	5/16	615	735	1310	380.00
42	8	1/4	5/16	5/16	480	575	1340	365.00
42	10	1/4	5/16	5/16	600	720	1580	425.00
42	12	1/4	5/16	5/16	720	865	1820	480.00
42	14	1/4	5/16	5/16	840	1000	2110	545.00
48	10	1/4	5/16	5/16	785	940	1875	490.00
48	14	1/4	5/16	5/16	1095	1300	2470	620.00
48	16	1/4	5/16	5/16	1250	1500	2735	690.00
48	20	1/4	5/16	5/16	1565	1880	3280	835.00
48	24	1/4	5/16	5/16	1880	2260	3830	965.00

Sizes other than those listed above quoted upon application.

COMPRESSED AIR TANKS

These compressed air tanks are adapted to public or private garage use.

All compressed air tanks manufactured by us, comply with the Canadian Interprovincial Regulations for the construction and installation of tanks and receptacles for compressed air and other gases.

Designs have been approved and registered by the Provinces of British Columbia, Alberta, Saskatchewan, Manitoba and Ontario.

Tanks 18-in. to 24-in. in diameter are fitted with two 2½ x 3½-inch handholes in the shell. Tanks 24-in. to 36-in. in diameter have two 4 x 6-inch handholes. Tanks over 36-in. diameter are provided with a manhole 11 x 15 inches.

NOTE—In order to facilitate the delivery of tanks over 24-in. diameter, buyer should furnish a sketch showing position and sizes of inlet and outlet. If these sizes are not known, buyer should state for what purpose the tank is to be used, and the size of compressor.

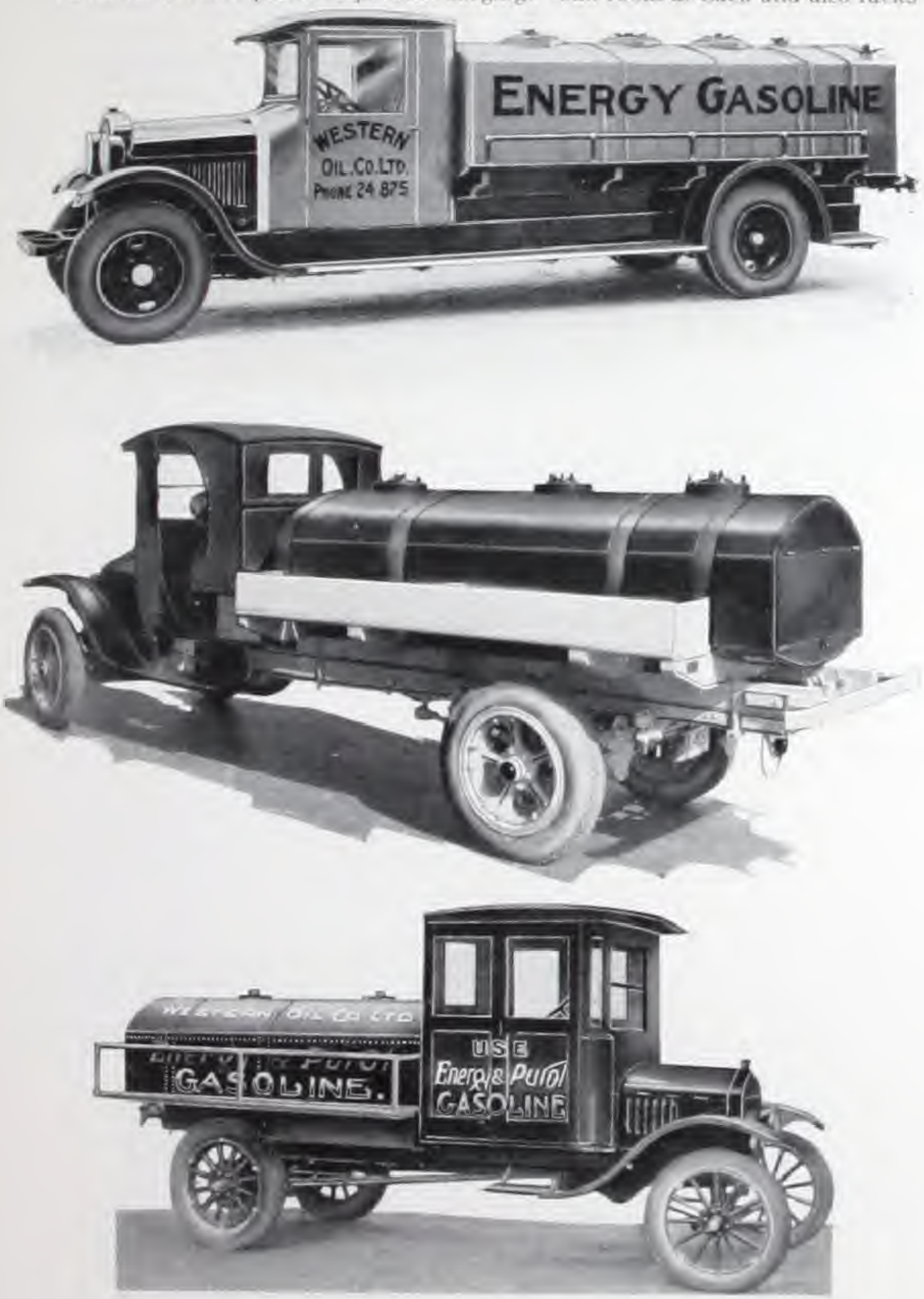
No. 86 (At Left)—Compressed Air Tank

Size		Thickness of Material		Cubic Feet Capacity	Approximate Capacity		Approx. Weight Lbs.	List Price
Dia. in Inches	Length in Feet	Shell	Heads		Imp. Gals	U. S. Gals.		
12	3	3/16	3/16	2½	15	18	105	$ 37.00
14	4	3/16	3/16	4½	30	36	154	41.00
14	5	3/16	3/16	5	35	42	185	46.00
16	5	1/4	1/4	7	45	54	286	58.00
18	5	1/4	1/4	9¼	55	66	334	69.00
20	5	1/4	5/16	11	70	84	395	75.09
20	6	1/4	5/16	13½	85	102	450	85.00
24	5	1/4	5/16	16	100	120	490	87.00
24	6	1/4	5/16	19	120	144	560	100.00
30	5	5/16	3/8	24	150	180	800	137.00
30	6	5/16	3/8	29	180	216	905	156.00
30	8	5/16	3/8	39	245	294	1115	194.00
36	6	3/8	7/16	42	265	318	1320	181.00
36	8	3/8	7/16	56	350	420	1620	231.00
42	8			77	480	576	....	
42	10			96	600	720	....	
42	12			115	720	864	....	
48	10			125	785	942	....	Prices on Application
48	12	Special		150	935	1122	....	
48	14			176	1095	1314	....	
60	12			235	1470	1764	....	
60	14			275	1700	2040	....	
60	16			315	1950	2340	....	

TRUCK TANKS

Steel tanks for gasoline and oil delivery trucks, supplied in capacities up to one thousand Imperial gallons, in as many compartments as desired.

Tanks have baffle plates to prevent surging. Can room at back and also racks



No. 87—Types of Truck Tanks

at side if specified. Tanks for Ford trucks can be supplied with two compartments and can room, with capacity 250 Imperial gallons. These tanks can be made either rivetted or welded, and are tested and guaranteed gasoline tight.

WAGON OR TRUCK TANKS

The tank shown in illustration No. 88 is designed for use on an ordinary truck or wagon, where deliveries by means of tank are made only intermittently. When it is desired to use the truck or wagon for other purposes the tank can be easily removed.

No. 88—Portable Wagon or Truck Tank.

This tank is mounted on two wood bolsters with two pairs of small wheels and axles. The wheels have eccentric centres, and to remove tanks from truck or wagon, the eccentrics are turned by means of hand levers into a position which raises the tank on to the wheels so that it can easily be rolled into warehouse.

By reversing the operation, the tank sits rigidly on the floor of the warehouse.

TRUCK BODIES

No. 89—Typical Steel Truck Body.

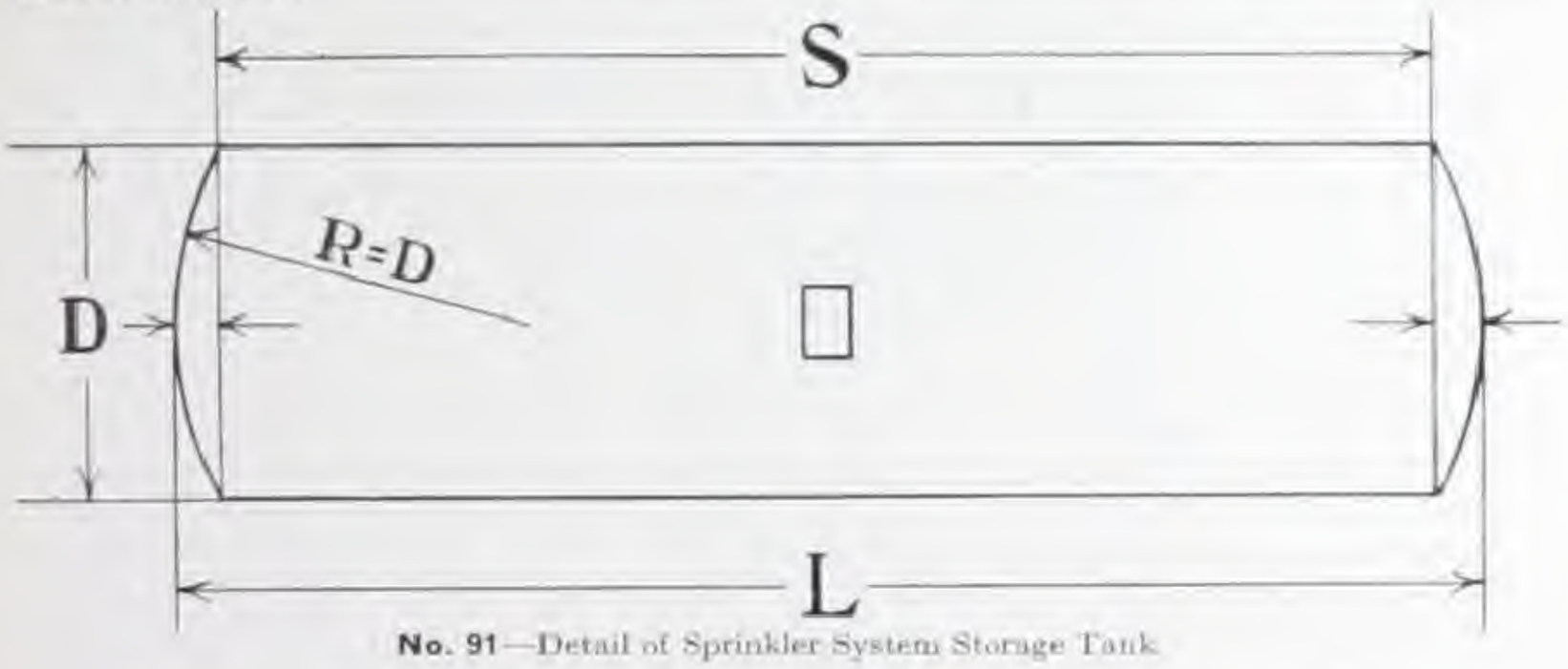
We furnish steel bodies for trucks in sizes and capacities as desired. The illustration above shows a typical truck body constructed to customer's design. Prices furnished upon request.

SPRINKLER SYSTEM STORAGE TANKS

Our tanks for sprinkler system storage are built to Western Canada Fire Underwriters specifications, and are inspected during construction by the Western Canada Fire Underwriters.

No. 90—Sprinkler System Storage Tank

The table below gives specifications for standard pressure tanks for sprinkler systems. All capacities for Underwriters' specifications are U.S. gallons. All diameters are inside shell. Flange quality stamped steel is the material used. Girth seams single rivetted; longitudinal seams triple-rivetted with butt-straps inside and out.



No. 91—Detail of Sprinkler System Storage Tank

SPECIFICATIONS FOR STANDARD SPRINKLER SYSTEM PRESSURE TANKS

Diameter D	Dish of Heads	S	L	No. of Sheets	S	L	No. of Sheets
		4500 Gallons			6000 Gallons		
60"	8 "	30'	31' 4"	4			
66"	8¾ "	24' 7"	26' ½"	3			
72"	9½"	20' 7"	22' 2"	3	27' 8"	29' 3"	4
78"	10½"	17' 4"	19' ½"	3	23' 4"	25' ½"	3
84"	11 "	14' 9"	16' 7"	2	19' 11"	21' 9"	3
90"	12 "	12' 8"	14' 8"	2	17' 2"	19' 2"	3
96"	13 "	10' 11"	13' 1"	2	14' 10"	17' 0"	2
		7500 Gallons			9000 Gallons		
78"	10½"	29' 4½"	31' 1"	4	35' 5"	37' 1"	5
84"	11 "	25' 1½"	26' 11½"	4	30' 4"	32' 2"	4
90"	12 "	21' 8½"	23' 8½"	3	26' 3"	28' 3"	4
96"	13 "	18' 10"	21' 10"	3	22' 10"	25' 0"	3

L = Length Overall S = Length of Shell Radius of Dish of Head = Diameter of Tank

One saddle is required under each sheet of shell, consisting of cast iron formed saddles resting on compound steel beam, varying in size according to spans. Separate price will be given on these on information as to spans required.

STEEL TANKS AND TOWERS

We can furnish water supply tanks and towers of any height or capacity for municipalities, railways or corporations; also steel towers for supporting wooden tanks, though we do not manufacture wooden tanks.

No. 92—A steel tank and tower designed and erected by the Manitoba Bridge and Iron Works, Limited.

We will design tanks and towers and give estimates of cost without charge to prospective buyers. When writing send all particulars covering height of tower and capacity of tank.

MUNICIPAL WATER TOWERS AND STAND-PIPES

We undertake to design, construct and erect complete elevated tanks or stand-pipes for municipal, domestic or railway water supply service.

No. 93—Elevated Water Tank at Tyndall, Man., Capacity 125,000 Gallons, with Suspended Drinking-Water Tank.

Specifications submitted on receipt of statement of storage capacity and head required. Drawings and estimates of cost will be furnished to prospective buyers.

No. 94—Vertical Storage Tank with Riveted Seams

STEEL STORAGE TANKS

Our steel storage tanks embody the latest developments in this class of work, being the result of twenty-five years experience in the steel and iron industry. As the largest producers of tanks in Western Canada, we are prepared to fill our customers' requirements, whether for standard or special designs. Our service is prompt and efficient.

We produce steel storage tanks, either horizontal or vertical, and with seams either welded or rivetted. All welding is done electrically, and all rivets in tanks are power-driven.

No. 95—Horizontal Storage Tanks with Electrically Welded Seams

The illustration on the opposite page shows a vertical storage tank with rivetted seams.

Above are shown horizontal storage tanks with electrically welded seams. This type of tank can be furnished with division plates to make two or more compartments.

All our storage tanks are made with one-piece bottoms or ends, and with large body plates, thus reducing the number of joints to a minimum.

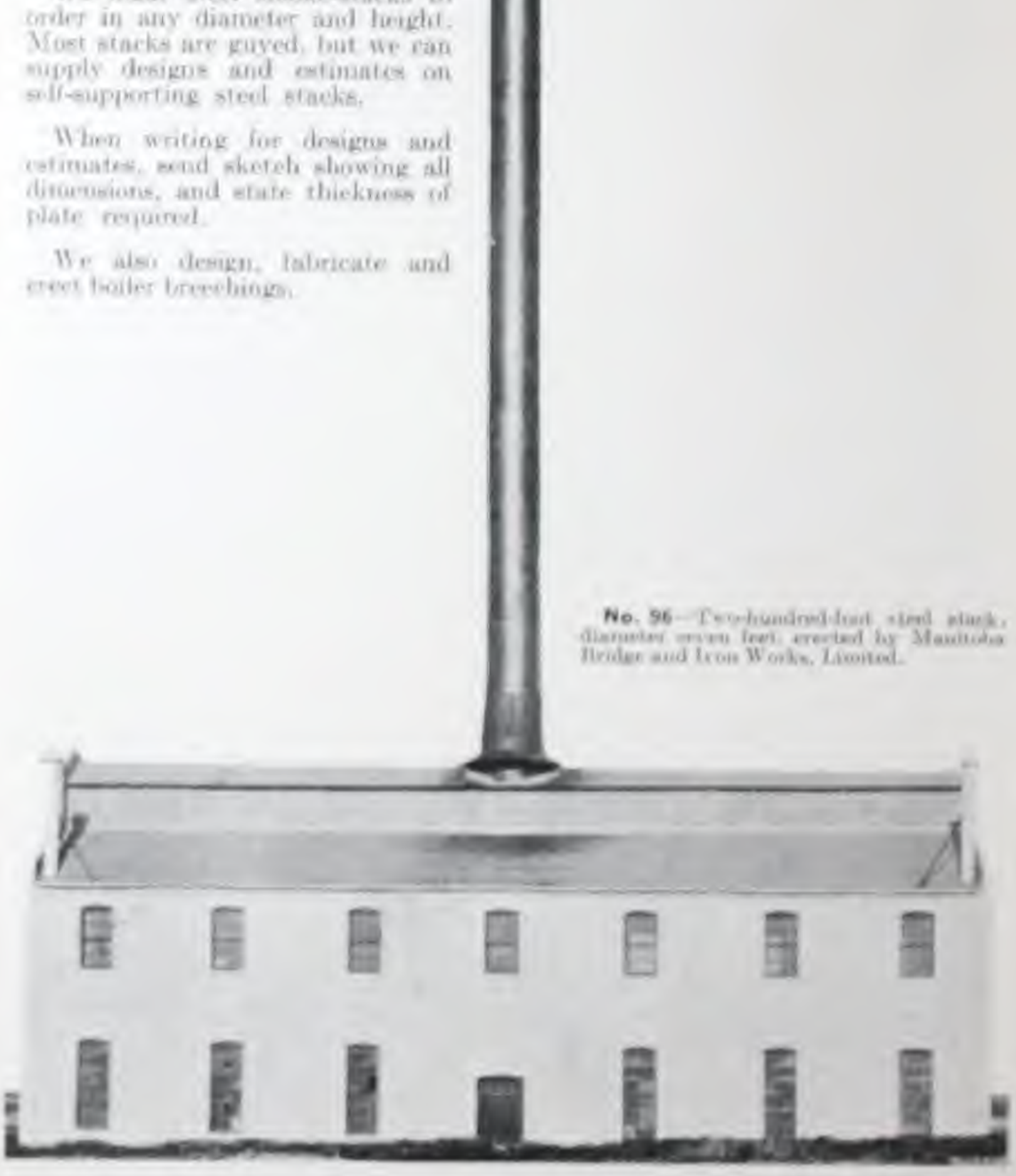
We can supply steel storage tanks in all sizes and to suit the customer's individual requirements.

STEEL SMOKE-STACKS

We make steel smoke-stacks to order in any diameter and height. Most stacks are guyed, but we can supply designs and estimates on self-supporting steel stacks.

When writing for designs and estimates, send sketch showing all dimensions, and state thickness of plate required.

We also design, fabricate and erect boiler breechings.

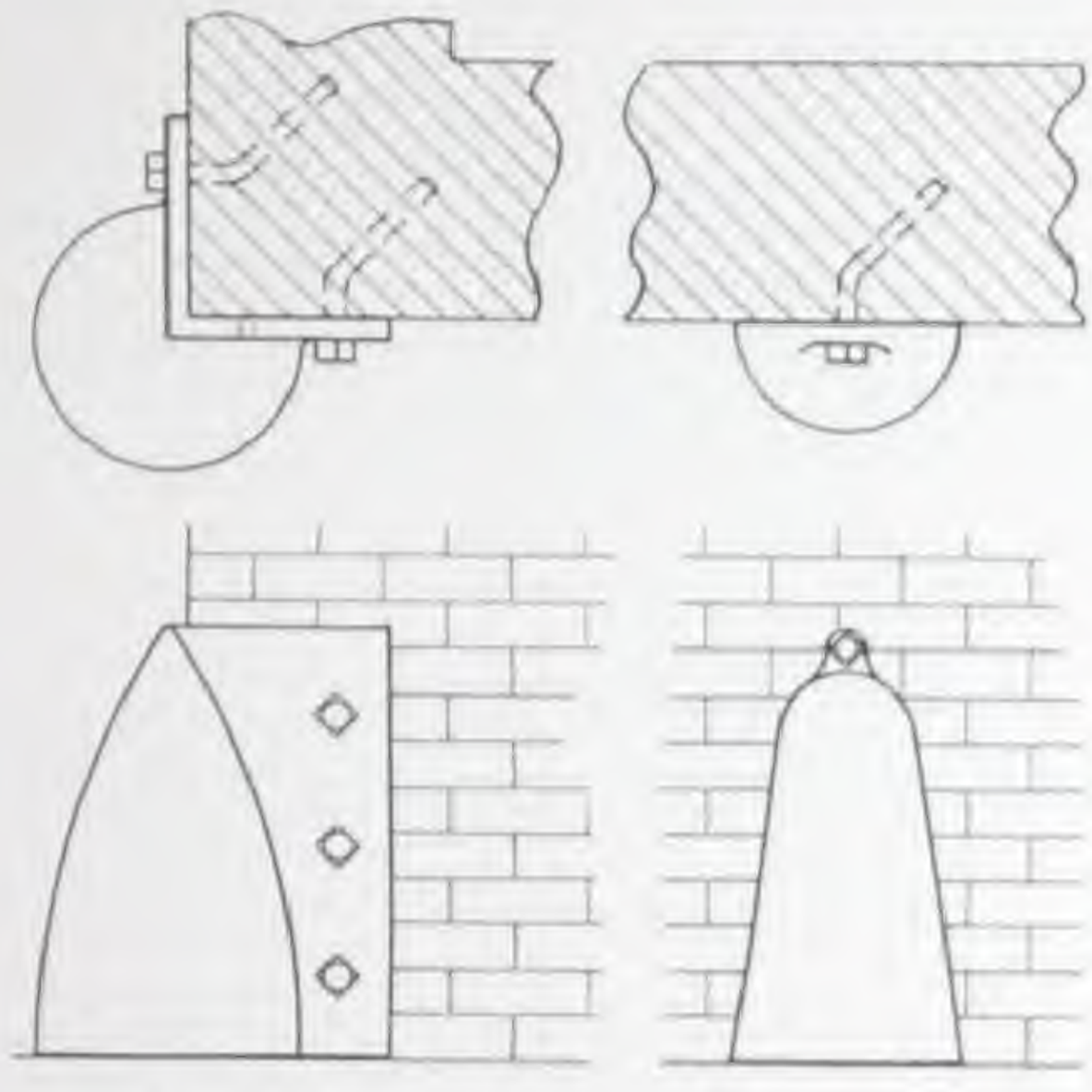


No. 96—Two-hundred-foot steel stack, diameter seven feet, erected by Manitoba Bridge and Iron Works, Limited.

WHEEL GUARDS

Wheel guards are used to protect corners and flat surfaces of walls at entrances to driveways and to warehouses and other buildings where trucks are driven in.

These guards are heavily constructed and securely anchored in the wall which they are designed to protect. Their cost is soon saved in damage prevented.



No. 97—Wheel Guards, for Corner and for Side of Wall

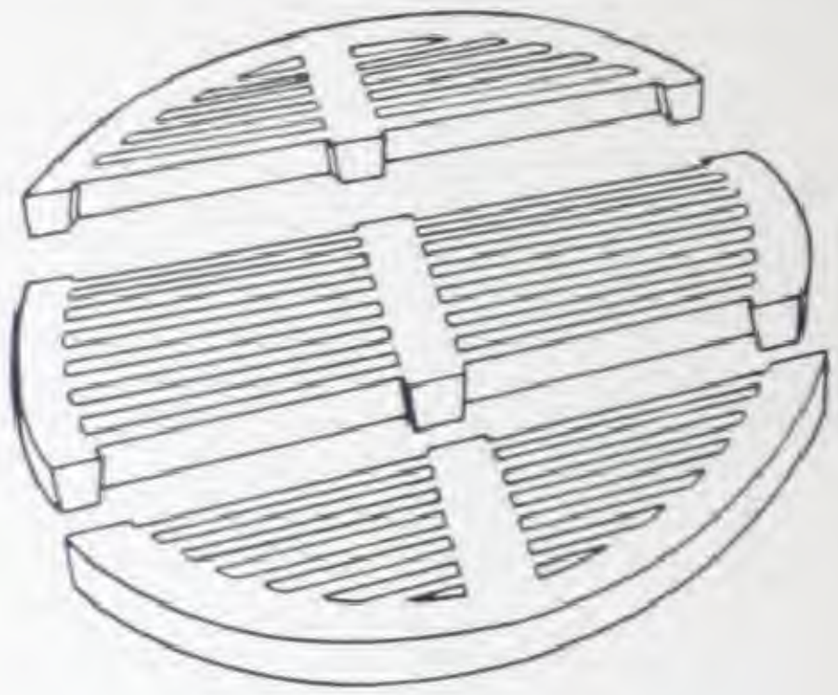
We have in stock patterns for all sizes and weights of wheel guards, and consequently are able to supply guards to suit any requirement on short notice.

We can also supply steel angle jamb guards with anchor, and either cast iron or plate steps, curbs and thresholds for door openings in warehouses, etc.

Any size or style, whether of steel or cast iron, can be furnished. In writing for prices, give all necessary information.

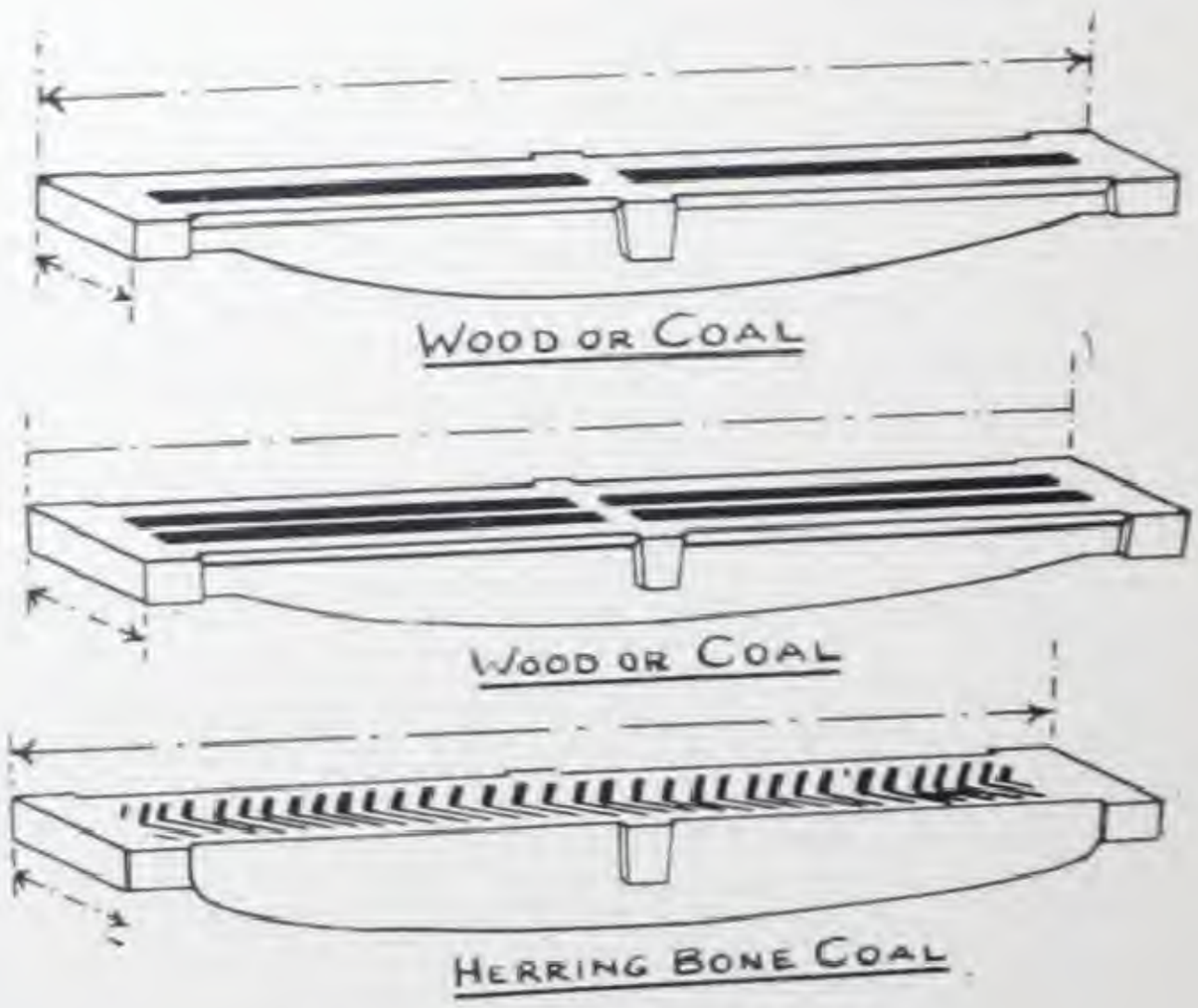
FURNACE GRATES

Many styles of furnace grates are now in use. Several varieties are illustrated on this and the following page. The number of patterns for furnace grates which we have on hand enables us to offer a considerable selection of castings.



No. 98—Circular Grate

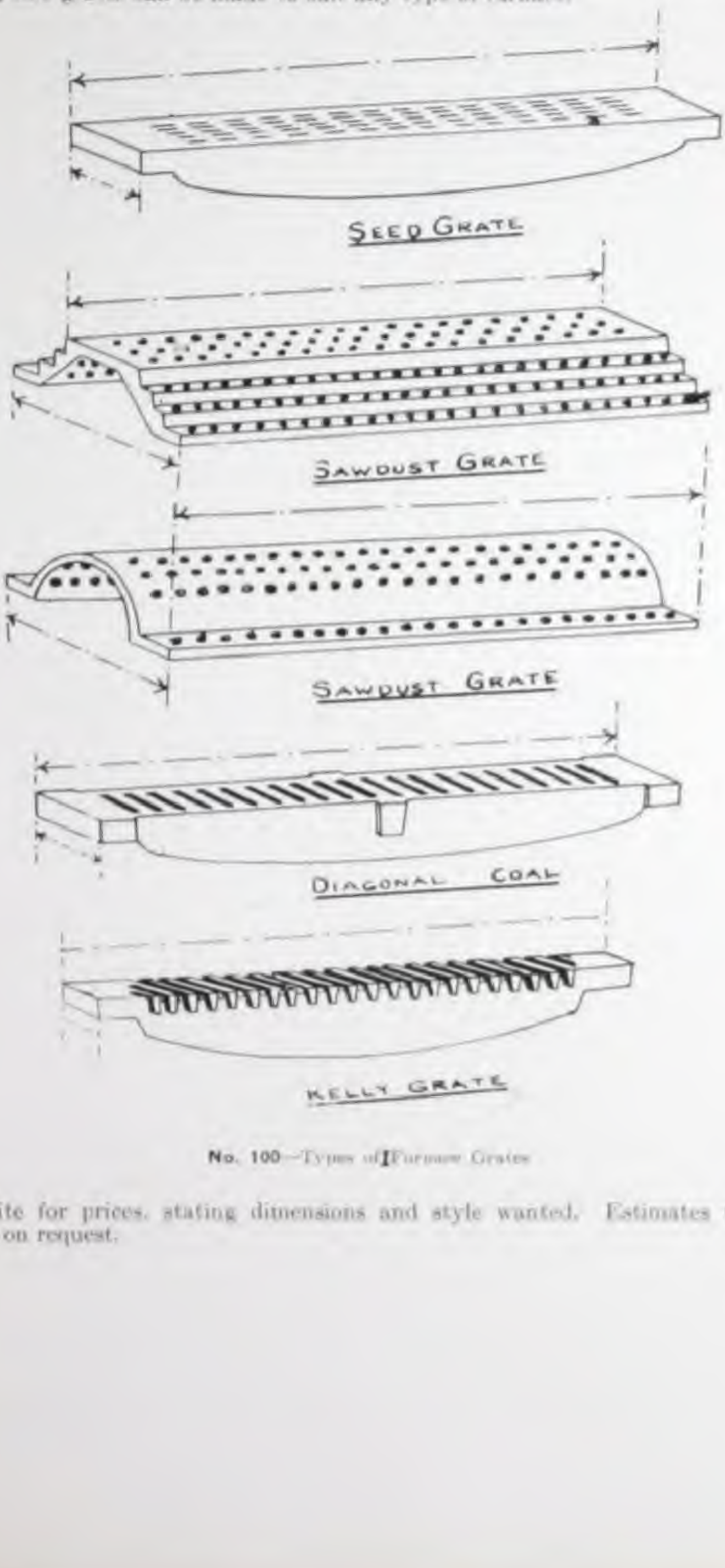
The illustration above depicts a circular style grate in three sections. This grate can be furnished in sizes to suit the customer's requirements.



No. 99—Types of Furnace Grates

In addition to the circular grate, many styles of rectangular sectional grates are used.

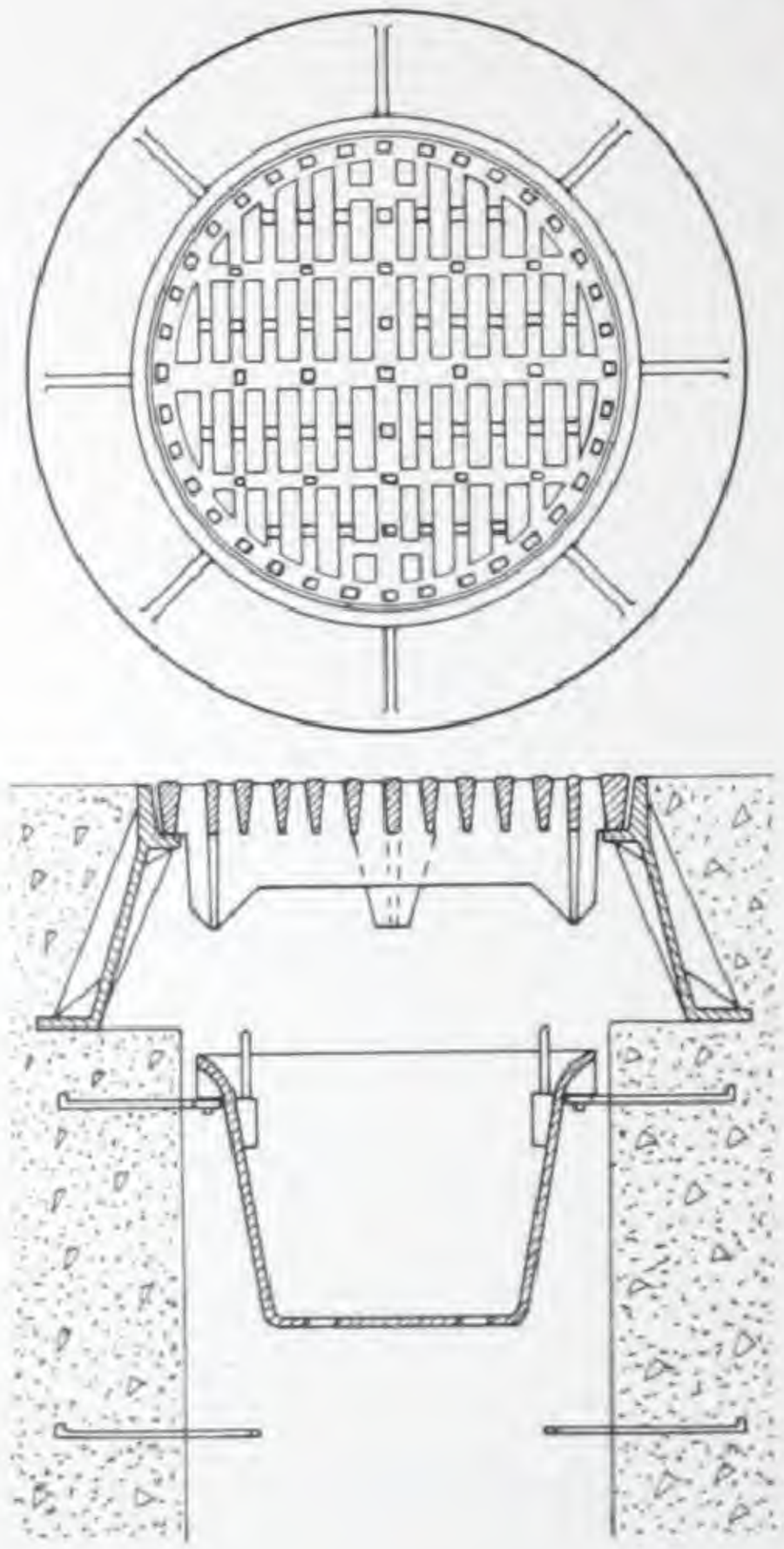
A number of additional varieties of furnace grates are shown in the designs below, and grates can be made to suit any type of furnace.



No. 100—Types of Furnace Grates

Write for prices, stating dimensions and style wanted. Estimates will be made on request.

SEWER CASTINGS



MUNICIPAL STANDARD MANHOLE FRAME AND COVER

The municipal standard manhole frame as illustrated at the left is especially adapted for city and town use.

This type of manhole frame can be supplied with solid cover as well as with grate cover shown in No. 101.

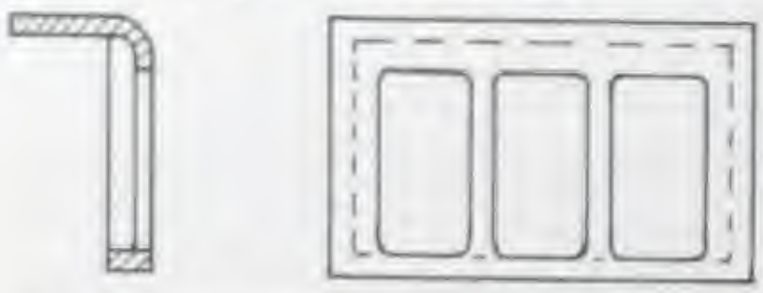
Our range of patterns enables us to offer numerous other types of manhole frames, while we can supply standards to suit the customer's individual requirements. Further information will be furnished on request.

MANHOLE MUD BASKETS

The mud basket shown fitted into the manhole in No. 101 can be supplied complete with brackets.

No. 101 (At Left)—Municipal Standard Sewer Manhole Frame Fitted with Grate Cover and Mud Basket.

CURB GRATINGS



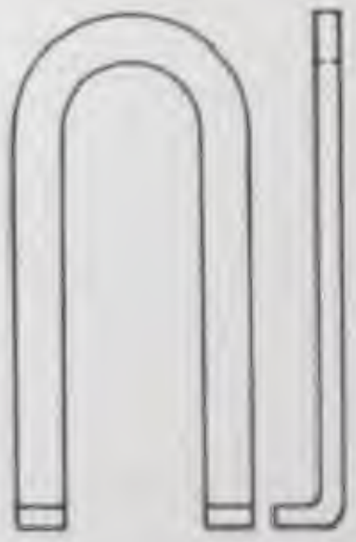
No. 102—Standard Cast Iron Curb Grating

The standard cast iron curb grating, illustrated above in No. 102, can be furnished to suit any depth of curb.

Estimates and further information furnished on request.

MANHOLE OR CATCH-BASIN STEPS

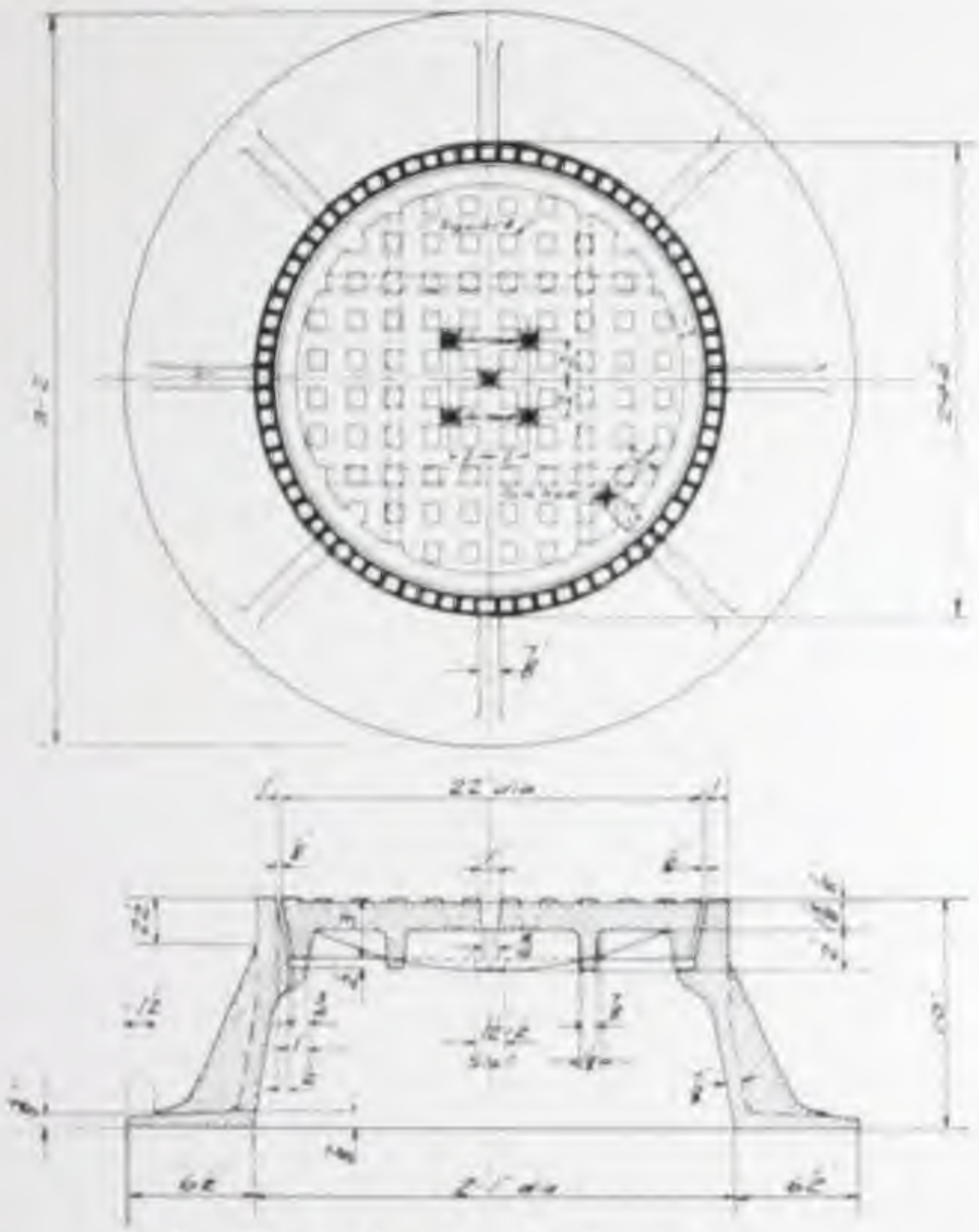
The wrought iron steps illustrated at the right are for use in manholes or catch-basins. They are shown in No. 101 above, as used in a manhole. Prices furnished on request.



No. 103—Wrought Iron Manhole or Catch-Basin Steps.

MANHOLE COVERS AND FRAMES

Our patterns for manhole covers and frames include those used by most of the cities of Western Canada, by the Manitoba Telephone System, Winnipeg Hydro Electric System, etc.

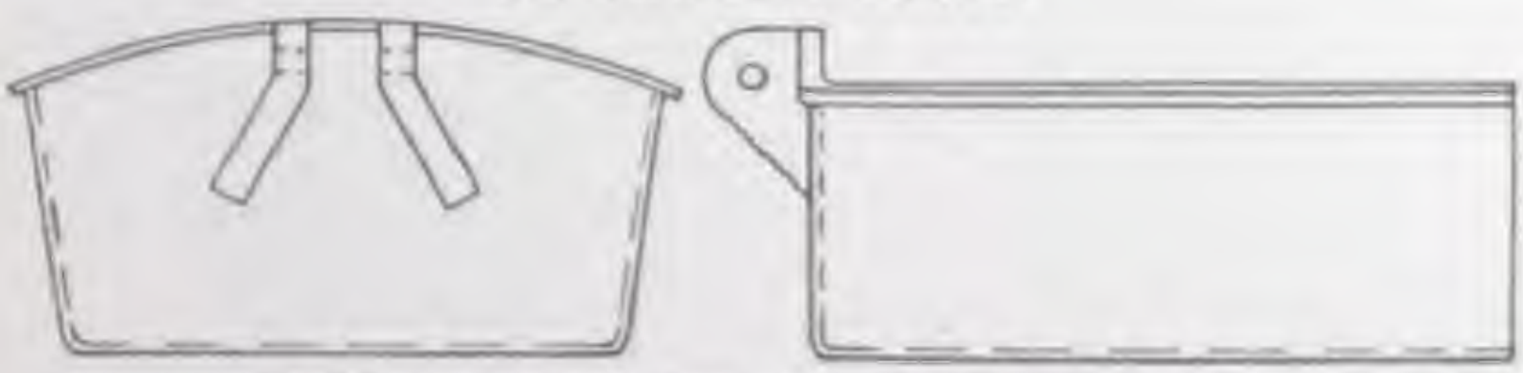


No. 104—Cast Iron Man-Hole Cover and Frame

Special air-tight covers with machined groove and oil seal can be supplied on order.

We make all kinds and sizes of manhole covers and frames. Estimates gladly given upon receipt of specifications.

CATCH-BASIN HOODS

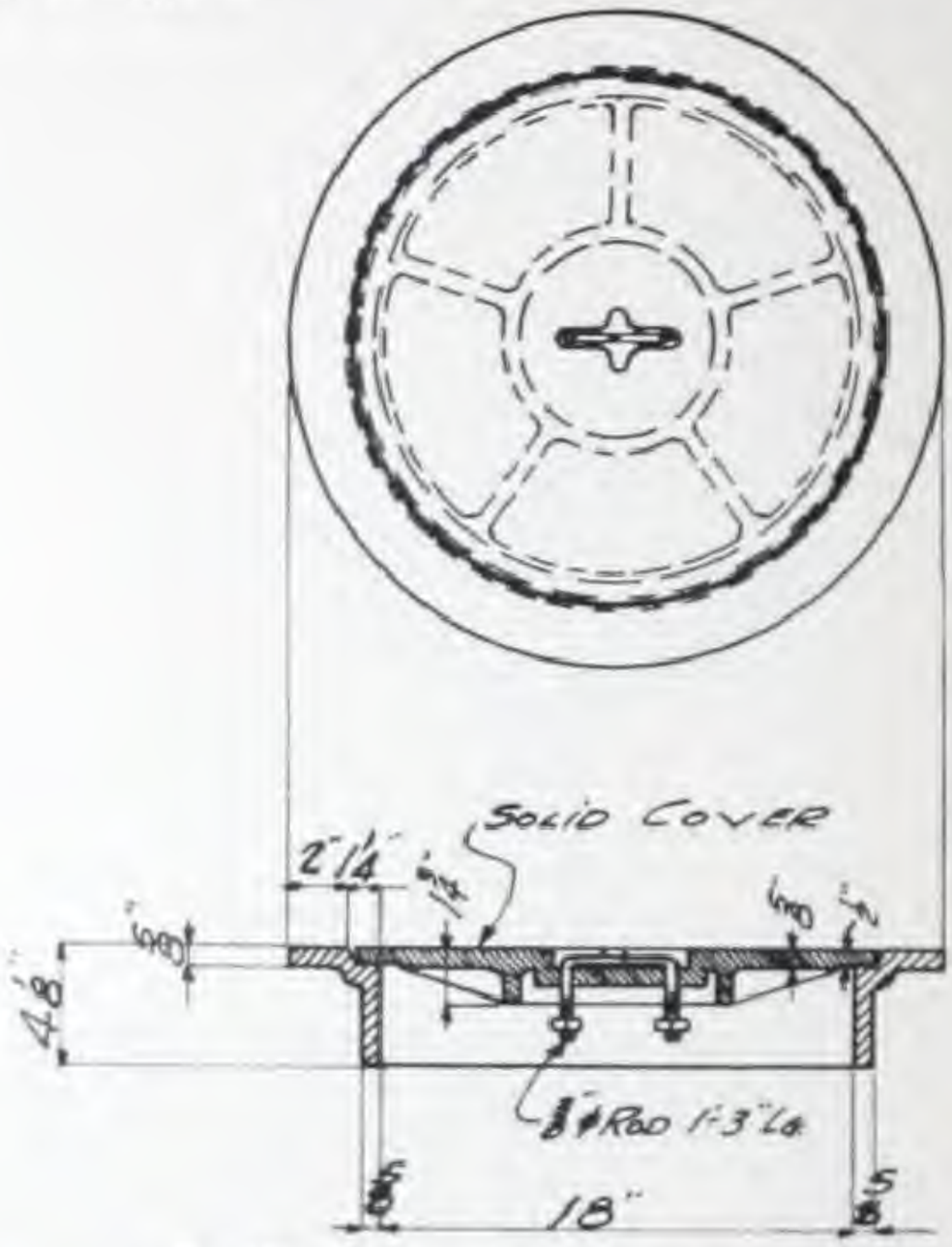


No. 105—End and Side Views of Standard Catch-Basin Hood

The standard catch-basin hood, shown in No. 105 above, is supplied complete with hinge and pin. Estimate will be furnished if requested.

CATCH-BASIN COVERS AND FRAMES

Covers and frames for catch-basins from 10-inch to 36-inch diameter and in heavy or light pattern, either solid or perforated, according to purpose intended, can readily be supplied.



No. 106—Cast Iron Catch-Basin Cover and Frame

Where heavy trucking may take place over a catch-basin, steel plate covers may be supplied to fit cast iron frames; these covers are lighter and stronger than the cast iron variety, and will not crack under load.

Coal-Hole Rings and Covers—The larger sizes of catch-basin covers, with the addition of an inside locking device, are used as coal-hole covers.

CLEAN-OUT DOORS

Cast-iron clean-out doors for general use can be supplied by us in the styles

No. 107—Circular Head Clean-out Door

No. 108—Rectangular Head Clean-out Door, Hinged

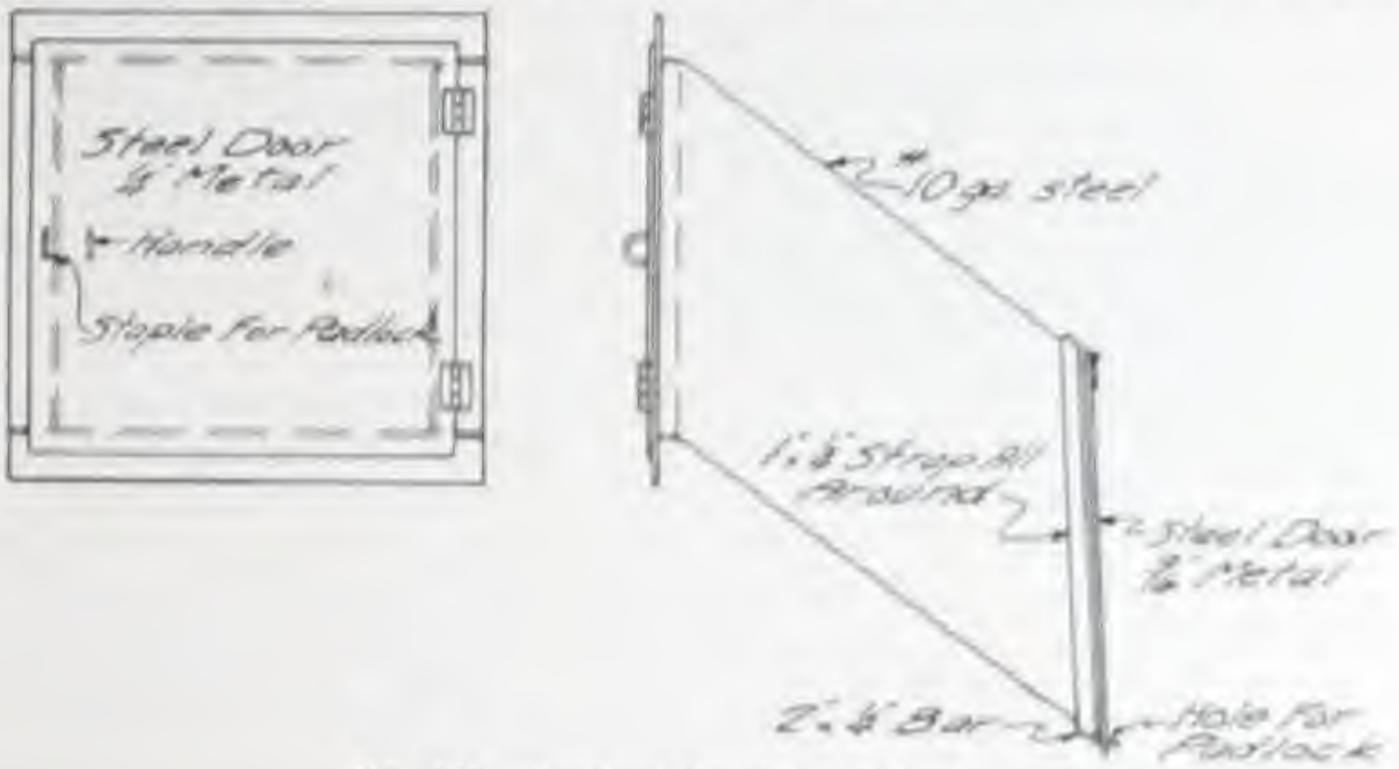
illustrated herewith, hinged or unhinged, with circular or rectangular head. Any size is obtainable. When writing for prices, state size of opening.

FUEL CHUTES

The selection of fuel chutes offered to our customers includes square and round, flush and projecting types; the chutes may also be for wall or sidewalk use.

SQUARE FLUSH TYPE

Our Standard All Steel Design—This pattern of fuel chute is featured by steel doors with locking devices at both inside and outside terminations of the of the chute. Highly durable and economical. Standard sizes shown below.



No. 109—Standard Sparte Fuel Chute

No.	Opening, In.	Depth Chute, In.	Weight, Lbs.
1	24 x 24	13	
2	24 x 24	17	
3	24 x 24	21	
4	24 x 24	27	
5	24 x 24	18	

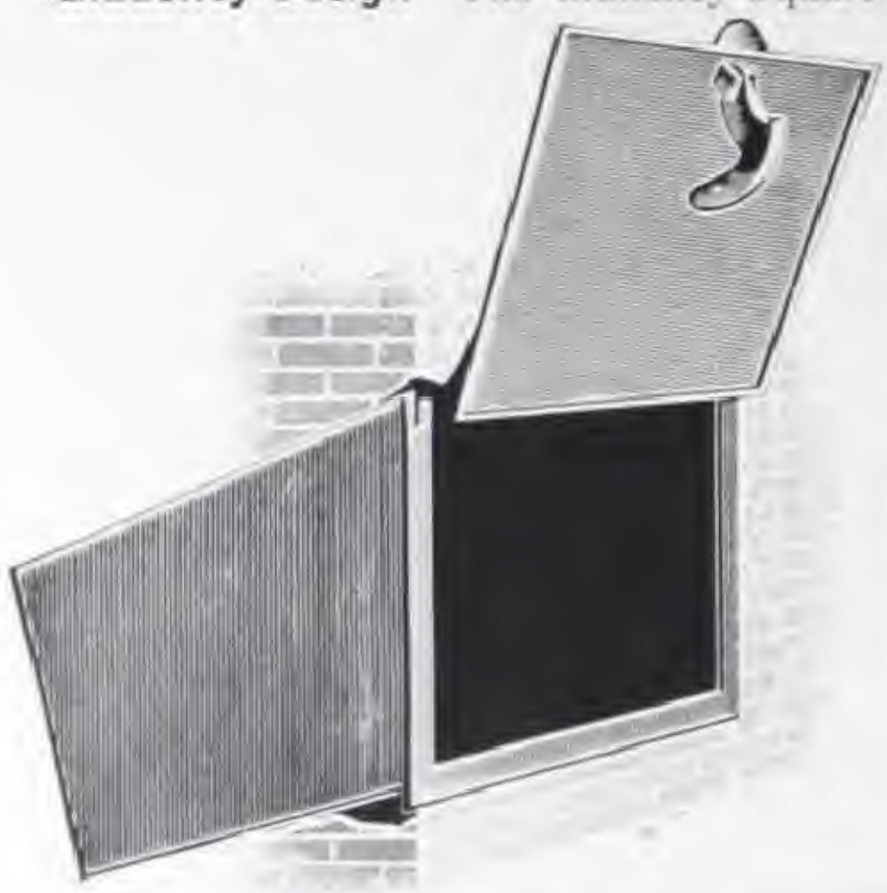
Majestic Design—The "Majestic" is a well-known pattern of the square flush type of chute. It is well-made, giving great convenience with a maximum of service, even under heavy use. It can be supplied with cast iron or glass door. The latter style is shown by No. 110. The standard sizes for this chute are tabulated below.

No. 110 (At Left)—Majestic Chute

No.	Opening, In.	Depth Chute, In.	Weight, Lbs.
10A—Glass Door	19 x 22	12	
10B—Iron Door	19 x 22	12	

Both our Standard and Majestic Designs are also made in Special Sizes.

Gibboney Design—The Gibboney Square Self-Locking Chute as seen in No. 111 is deservedly popular. It has a flanged door which fits over the rim of frame making it both wind and water proof.



The cast frame and door, combined with a sturdy steel body make the Gibboney a strong, reliable chute which will stand while the building lasts.

Ideal for receiving coal, wood or vegetables, and suitable for any style of building.

The door closes flush with the building and can be opened only from the inside.

No. 111 (At Left)—Gibboney Square Fuel Chute

MADE IN THE FOLLOWING SIZES:

No.	Opening, In.	Depth Chute, In.	Weight, Lbs.
4	18 x 18	24	70
5	18 x 24	30	105

Also made in sizes to suit individual requirements.

ROUND PROJECTING TYPE

Gibboney Design—The Round Gibboney Chute has practically the same features as the square type. It is self-locking and can be opened only from the inside. The frame and door are cast, while the body is of heavy steel.

The door is made with a flange which fits over rim of frame, making it wind and water proof.

The chute is neat in appearance and can be used in residences, business blocks, churches and other public buildings.

No. 112 (At Right)—Gibboney Round Fuel Chute

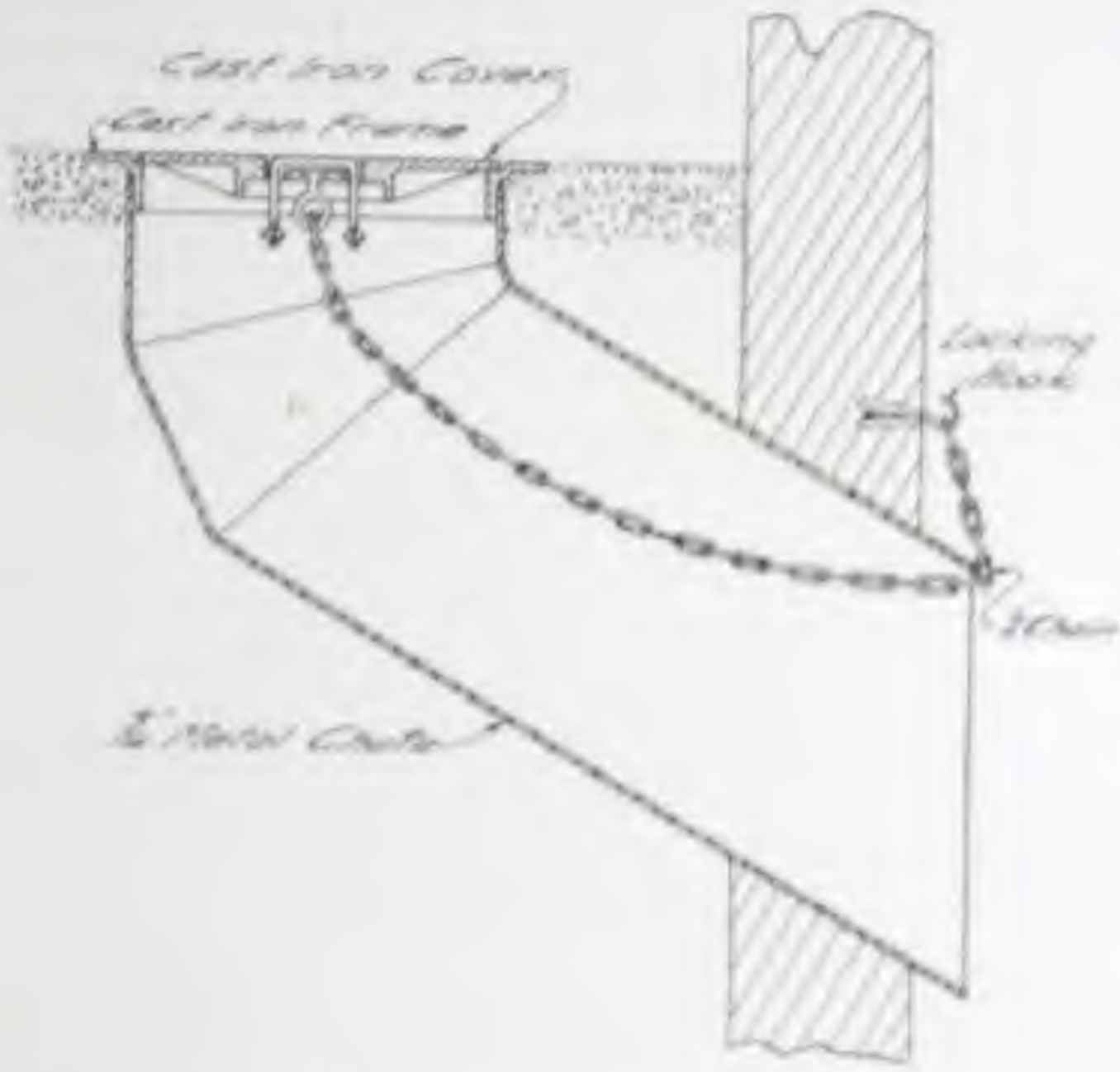
MADE IN THE FOLLOWING SIZES:

No.	Opening, In.	Depth Chute, In.	Weight, Lbs.
1	18 (diam.)	24	85
2	18 (diam.)	30	90
3	24 (diam.)	30	155

Also made in sizes to suit individual requirements.

ROUND SIDEWALK TYPE

Our Standard Design—This pattern of chute which passes through both sidewalk and wall is a popular style in cases where its use is suitable.



No. 113—Standard Sidewalk Chute

The heavy round cast cover fits into a frame built into the sidewalk. The chute passes down and through the adjoining wall into the interior of the building. The cover is fastened on the inside by a simple but effective locking device as shown in No. 113 above.

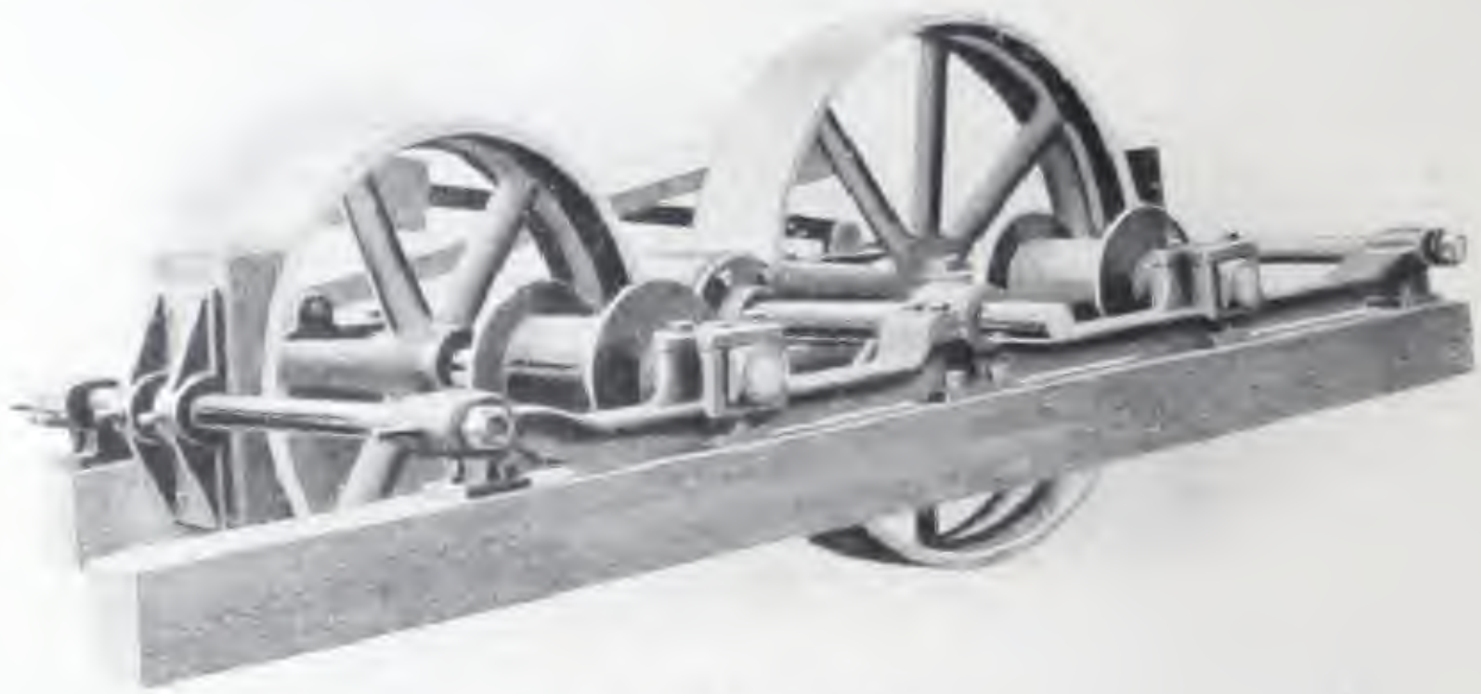
This chute is made in sizes to suit the specifications of the individual customer. Estimates gladly furnished.

PACKING HOUSE EQUIPMENT

We manufacture a varied range of equipment for use in abattoirs, cold storage plants, etc. In the design and construction of our products of this nature, every attention is given to assuring economical production in the packing industry. The following pages show some of the lines in which we specialize, but by no means indicate the limit of our ability; we can supply any requirement of this nature.

BEEF HOISTS

We can supply both single and double beef hoists to suit the requirements of any meat packer. The hoist shown on this page is a double hoist, equipped with heavy-rimmed friction wheels, accurately machined and balanced. The paper friction is constructed with a cast iron sleeve and held firmly by bolts through the paper and flanges.



No. 114—Beef Hoist

The frames are of a heavy flanged ribbed construction and are made from high-grade cast iron, same as is used for machine castings They are machined on the bottom of the frame and the bearings are babbitted with high grade babbit in perfect alignment with the lower surface so that in erecting these frames on overhead timber or steel beams it is not necessary to use liners under frames to line them with other shafts.

The weight levers are forged from high-grade steel. The sliding boxes on the friction wheel shaft are designed so that there will always be a square contact on the paper friction by the friction wheels.

The brakes are adjustable so that the brake block can be set squarely and in perfect alignment on the face of the friction wheel. The tie rods are made of heavy steel. The line shaft carrying paper friction is not furnished unless specified in order.

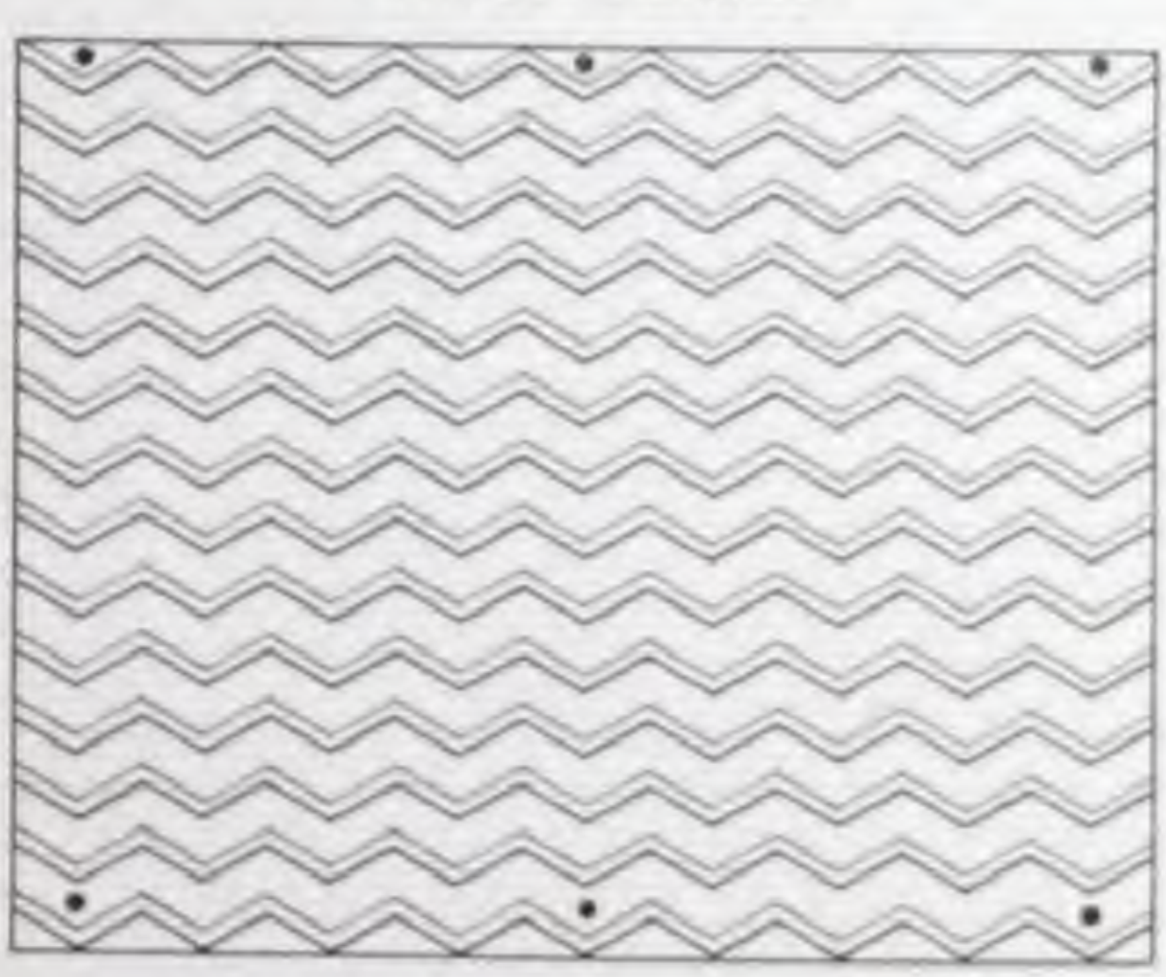
In ordering, state whether single or double hoist is desired.

TRACK HANGERS

No. 115 No. 116 No. 117

The illustration above shows three standard types of hangers to support overhead tracking. They are the strongest hangers for their weight obtainable, and in them are incorporated all the latest improvements. No. 115 is a cast iron track hanger; No. 116 is a soft steel track hanger; No. 117 is a cast iron stocking rail hanger. In ordering, specify length of drop, width of track, and style desired. We also roll all different types of steel track.

PRITCH PLATES



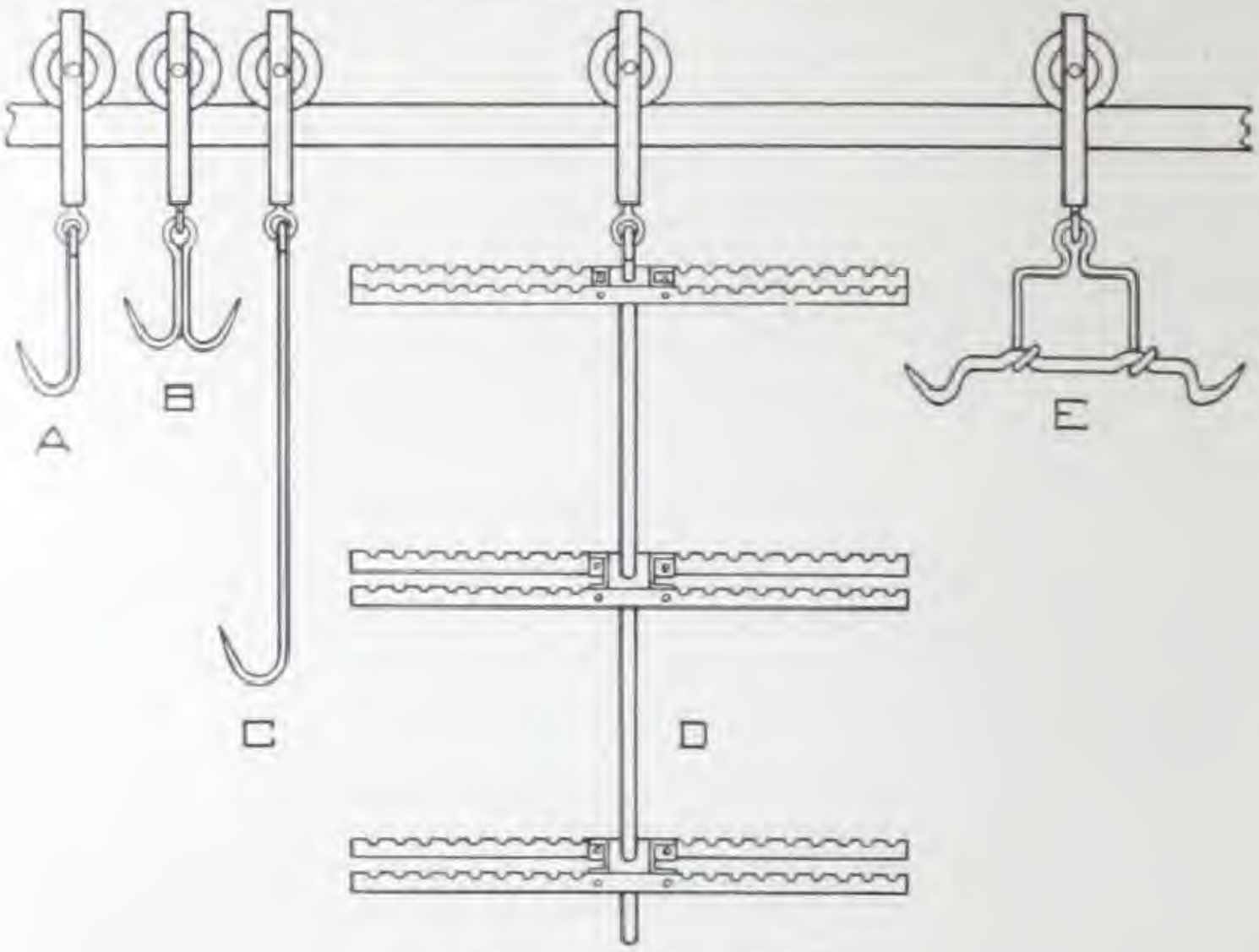
No. 113

Pritch plates for the beef dressing floor of heavy cast iron with special ribbed surface as illustrated above can be furnished in various sizes to suit conditions.

Made in different designs, varying in weight from 13 to 27 lbs. per square foot.

MEAT TROLLEYS

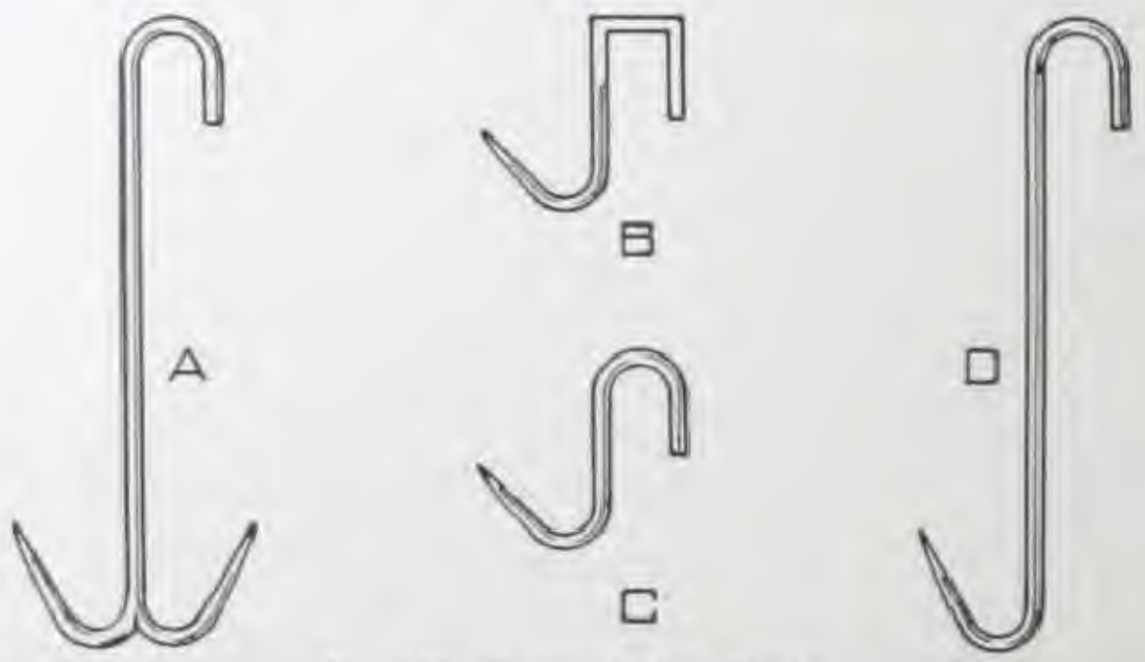
We can supply the most modern and improved designs of trolleys for packing-houses and markets. The wheels are machined in the groove and run on cold rolled steel pins, which makes them very easy to operate.



No. 119—Standard Meat Trolleys

In the illustration above, A represents a hind-quarter beef trolley; B, a double-hook sheep trolley; and C, a fore-quarter beef trolley. A three-station smoke-house trolley is shown by D, while E shows a hog trolley with steel gambrel. Other styles may be had to suit individual requirements.

CAR AND MEAT HOOKS



No. 120—Types of Meat Hooks

Above are shown some of the types of hooks made for packing-house use. Single and double car hooks are shown by A and D; C represents a shorter car hook, while B shows a meat hook. These hooks can be furnished black or tinned.

DUPLICATE SWITCHES

Fig. 108. Duplicate Switch.

Fig. 109. Duplicate Switch.

The Duplicate is assembled the same building article as Fig. 1 switches in every essential article. If in this instrument the contacts on a back switch are offset, it is desirable to finish the mounting Fig. 108 a different front view.

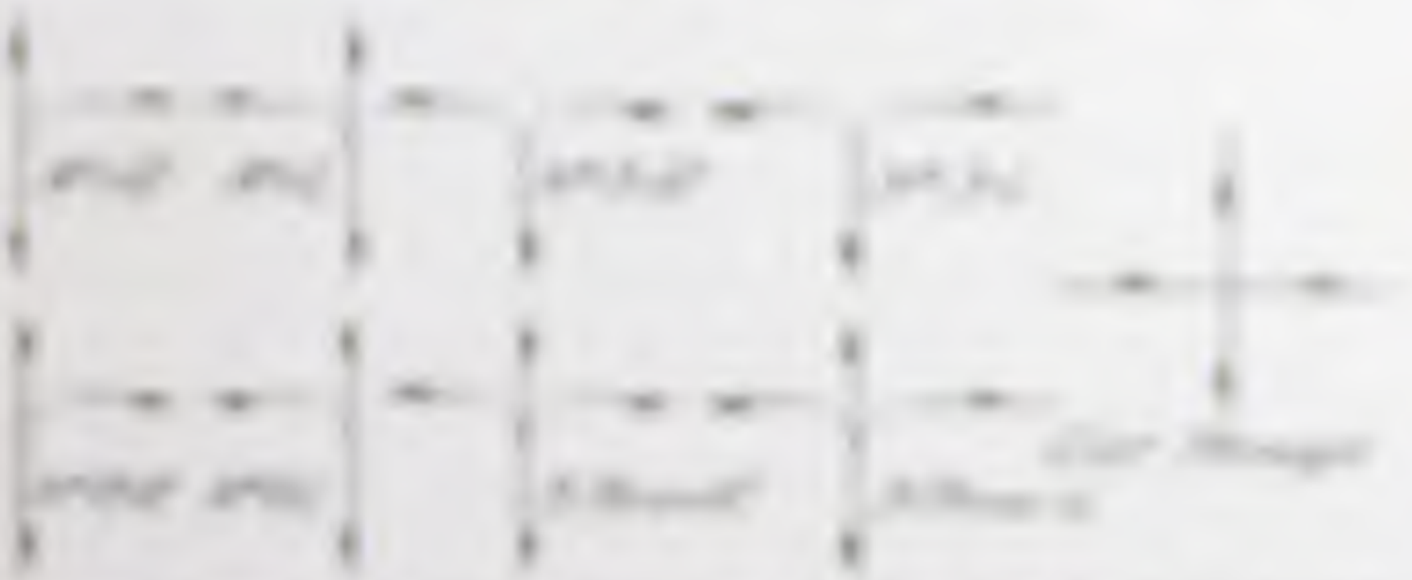


Fig. 110. Duplicate Switch.

The device shown will not be entirely satisfactory. The solid block supporting the slide at mounting the hangers should be placed more to suit the movement desired, to obtain the position required for the front switch.

PACKING-HOUSE TRUCKS

We can supply a variety of styles of meat trucks for packing-house use, which will prove well adapted to the style of work done by packers.

No. 123—Sanitary Meat Truck

A popular model is shown by No. 123 above. The body is made of No. 14 steel with all seams welded, which makes it easy to clean. It is made up complete and then galvanized so that all crevices are filled and the body is protected by the heaviest possible coat. Well-rounded corners insure the greatest possible sanitation. The reinforced edge is constructed by bending the sheet over and under, forming a beading which is perfectly smooth and free from crevices. All wheels are accurately fitted to the proper size and with a smooth-running fit on the axle, thereby reducing friction to the minimum.

No. 124—Tank-Charging Truck

The galvanized steel truck shown by No. 124 is well adapted for all work requiring the use of a round-nose truck. The body is made of No. 12 steel with welded seams, rounded corners and galvanizing features as in the model shown by No. 123.

Trucks can be constructed in sizes and styles to meet the ideas of the customer. Please furnish us with particulars and your requests will be accorded the closest attention.

RENDERING TANKS

Rendering tanks for any purpose, and in any size to suit the customer's requirements, can readily be supplied by us.

The illustration at the left shows a typical steam rendering tank for steaming stock from butchers and other sources, but built of best condemned parts of material.

It is constructed of heavy boiler steel, with large inlet and discharge openings, and is provided with draw-off cocks to remove the grease. It can be furnished in any size and for any purpose. Catalogue gladly furnished.

Fig. 12B. 150 Gallon Rendering Tank

LARD KETTLES

The type of jacketed steel-packaged lard kettle shown herewith is made in six standard sizes, varying from 50 to 300 gallons in capacity.

Discharge connections, air valves, drop valves, steam gauge and draw cock for charging the kettle.

The kettle herewith shown the illustration of the standard sizes of lard kettles.

Capacity Gallons	Diameter Inches	Depth Inches	Weight Lbs.
50	32	18	850
100	36	24	1,000
150	36	36	1,200
200	44	36	1,400
250	48	42	1,600
300	54	48	1,800

Fig. 12B. Lard Kettle

POLE LINE HARDWARE

We carry a full line of pole line hardware, available in stock sizes, as noted in the following paragraphs, or in additional sizes on special order; the material can be supplied either plain or galvanized by the "hot-dip" process.

Eye Bolts—These bolts can be made in any size desired and with eye welded

No. 127—Eye Bolt

or not welded and with square nut. Stocked in the following sizes and weights:

Size, In.	Weight per 100 Lbs.
⅝ x 20	227
⅝ x 22	240
⅝ x 24	260

Machine or Pole Bolts—This style of bolt has a square head and nut; sizes

No. 128—Machine Bolt

13 inches long and shorter have four inches of thread, while sizes longer than 13 inches have six inches of thread. The following sizes are stocked:

Size, In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lbs.
⅝ x 10	101	⅝ x 16	150
⅝ x 12	117	⅝ x 18	171
⅝ x 14	133	⅝ x 20	192
⅝ x 15	140		

Double Arming Bolts—Made with two square nuts and four inches of thread

No. 129—Double Arming Bolt

on each end. Can be supplied to suit any specifications. Stock sizes are:

Size, In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lb.
⅝ x 12	131	⅝ x 18	190
⅝ x 14	150	⅝ x 20	212
⅝ x 16	170		

Cross-Arm Braces—Standard cross-arm braces are one inch or 1¾-inch wide,

No. 130—Cross-Arm Brace

with $\frac{3}{16}$-inch holes at ends, center of hole one inch from end of brace. Lengths are as specified. Stock sizes are:

Size, In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lbs.
¼ x 1 x 24	167	¼ x 1¼ x 24	212
¼ x 1 x 26	181	¼ x 1¼ x 26	230
¼ x 1 x 28	195	¼ x 1¼ x 28	247
¼ x 1 x 30	215	¼ x 1¼ x 30	265

Transposition Brackets—These brackets are for use with plates at horizontal

No. 131—Transposition Brackets

angles. Provided with square nut and round plate washer. Made to suit specifications standard size is:

Size, In.	Weight per 100, Lbs.
4½ x 10½	365

Guy Clamps—Made of rolled steel with longitudinal groove to grasp wire

No. 132—Wire Rope Guy Clamp

No. 132A—Flat Bar Guy Clamp

rope grooved twice for inside plate or with raised grip. Provided for small wire rope or flat bars. The following are the stock sizes:

Size, In.	Weight per 100, Lbs.
⅜ inch x 4	40
½ inch x 5	114
⅝ inch x 6	198

Anchor Rods—Made with drop forged or long welded eye or loop end and flange

No. 133—Anchor Rod

with thread and nippers one or other end. The following sizes are carried in stock:

Size, In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lbs.
¾ x 8	263	¾ x 10	327
¾ x 9	296	¾ x 12	392
¾ x 10	327	¾ x 14	457
¾ x 11	359	¾ x 16	522
¾ x 12	392	¾ x 18	587
¾ x 13	424	1 x 24	1044
¾ x 14	457	1 x 30	1305
¾ x 15	489		

Gooseneck Hooks—These rods are made of rolled steel and may be supplied drilled and pointed or drilled, pointed and screwed. The following sizes are carried in stock:

Discount 20% Pending		Discount, 67 percent and 5 points	
Size, In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lbs.
¾ x 72	830	¾ x 60	830
¾ x 78	898	¾ x 72	996
¾ x 84	966	¾ x 84	1162

Lag Screws—These screws are made with square head, cone-point drive and cut thread. We carry them in the following stock sizes:

Size, In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lbs.
¼ x 2	7	⅝ x 3½	31
⅜ x 2½	8½	⅝ x 4	41
⅜ x 3	10		

Pole Shims—The standard sizes of pole shims are as follows:

Size, In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lbs.
⅛ x 1 x 6	22	¼ x 4 x 8	43

Wire Rope Thimbles—Made of iron or mild steel and stocked in the following sizes:

Size, In.	Weight per 100, Lbs.
⅞	7
1	12

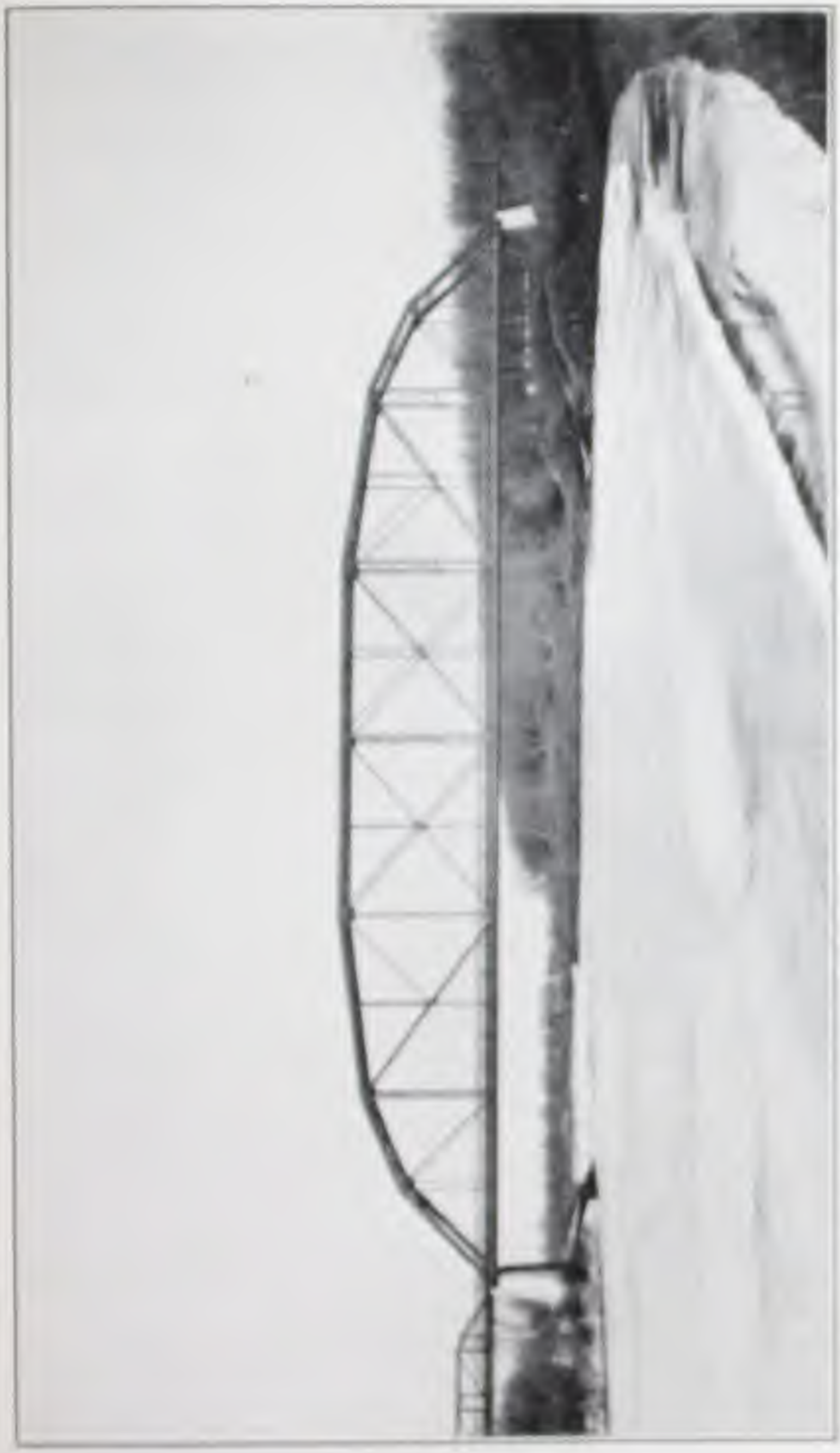
Square Washers—Made of pressed steel plate with punched hole. Following are stock sizes:

Size, In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lbs.
2½ x 2½ x ⅛	25	4 x 4 x ¼	115
2½ x 2½ x ¼	32	4 x 4 x ⅜	140
2½ x 2½ x ⅜	41	4 x 4 x ½	170
4 x 4 x ⅜	85	4 x 4 x ¾	227

All the previously mentioned lines of pole line hardware can be supplied either plain or "hot-dip" galvanized, and to any specifications whether provincial government, telephones or railway telegraphs.

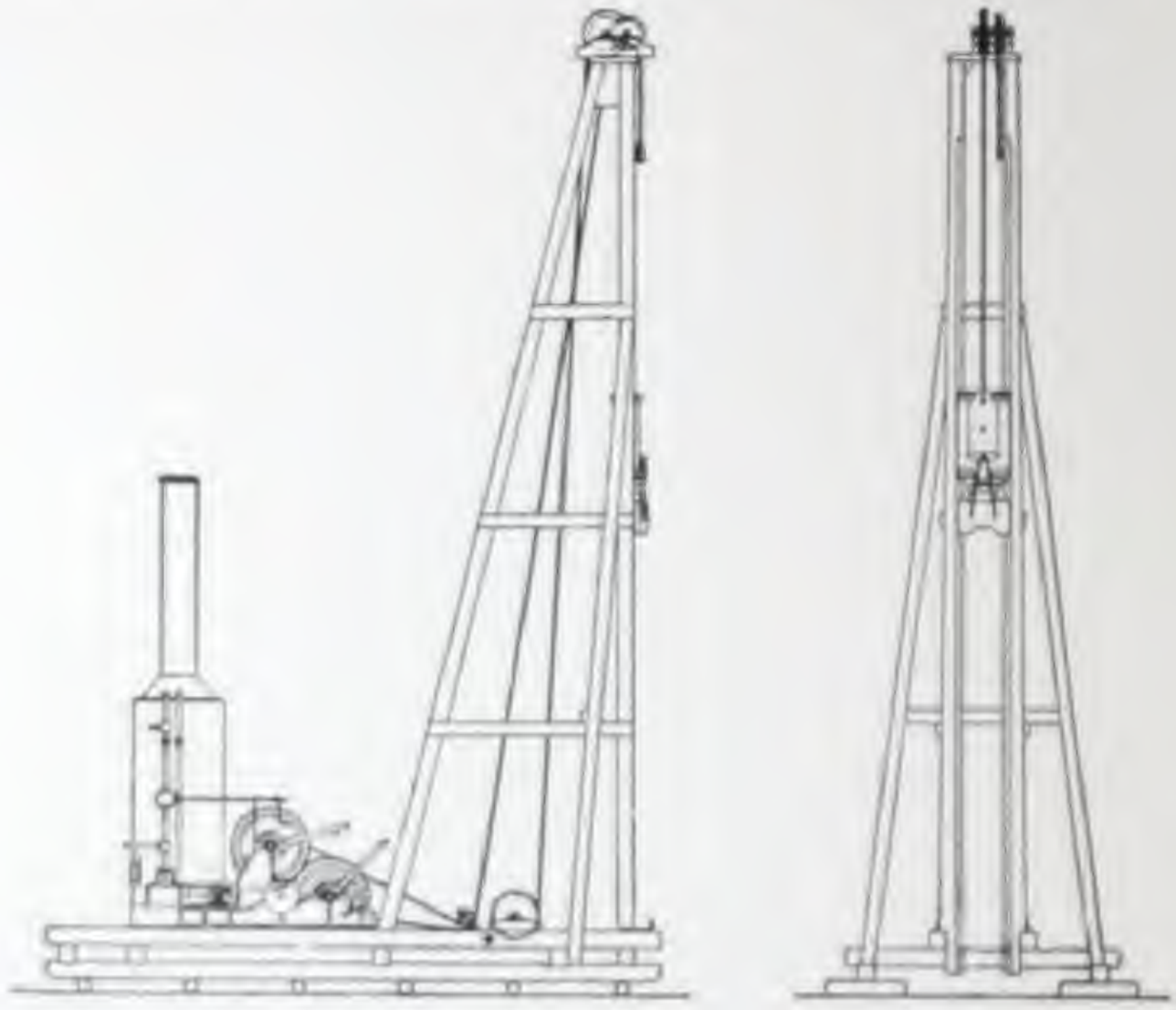
COMMERCIAL GALVANIZING

We are fully equipped to handle orders of galvanizing for special commercial purposes, such as tanks, locks, angles, power rods, castings, etc. This galvanizing can be done either by the "hot-dip" or by the cold electrolytic process.



PILE-DRIVERS

We furnish all iron-work required for any style of pile-driver, but we do not handle the wooden portion of the frame-work. A full set of iron-work usually



No. 136—Contractor's Standard Pile-Driver with Extension Sills

consists of the following: Hammer, with steel pin fitted in; top sheaves; shafts; boxes and bolts; toggles with bolts; and channel iron liners with bolts and washers. When a pile cap is used, toggles are not required.

The illustration No. 136 shows a contractor's standard driver with extension sills, adapted to carry the engine. They are also constructed with shorter sills for use when the engine is located elsewhere or when it is necessary to move the leaders in a circle for the purpose of driving a number of piles in a limited area.

A special form of this driver can be arranged by leaving out the rollers under the sills and substituting rigid roller bearings. Four of these would be used, bolted directly to the lower sill, using either the 10-inch iron pipe or 10-inch oak rollers, the roller lying across the driver instead of lengthwise.

Other types of pile-drivers may be constructed to suit customers' specifications; our engineering department will make up designs of any kind of pile-driver for our customers without charge.

Prices on all iron-work will be supplied on request. When ordering or asking for prices, state fully dimensions of driver and give list of iron-work required.

PILE HAMMERS

Fig. 130. Pile Hammer

We have numerous patterns in stock from which we can supply pile-hammers of all sizes and weights, we are also able to make pile-followers to any specification.

Illustration No. 147 shows a 3000-pound pile-hammer with diamond and square jaw castings of the variety now in current use and very powerful.

In ordering, we ask to enquire the best form of hammer suitable for the purpose, and we give careful attention to these points (as):

1. To get as much of the weight as possible to the bottom of the hammer.

2. To have the hammer as long as the size of leaders will permit. This gives longer bearing to the guides.

3. To have as little slack as possible between the hammer and the anvil. This is required to obtain as much as possible the full to the benefit of the pressure.

PILE-CAPS AND COVERS

Fig. 131. Cast-iron Cap

In manufacturing work, piles are required to be driven below the surface accurately 30 feet. When driven to the end of the leaders, a follower has to be used for the remaining distance. The follower may shown in Fig. 130, is inserted on the hammer, the same as the pile cap, to fit over the pile. In the upper end the centering recess and holds a pile of the ordinary length, with an upper end trimmed to fit into the pile cap or driven hammer. It is usually three feet long in this case. A pile is put up to 12 inches diameter; the upper recess is for a 7 inch diameter follower and up to 16 inches deep; the opening is 12 inches long overall. Holes are worthwhile. Many can prove existing what are required.

To position pile heads from the wooden top at the accurate time to arrive at an efficient advantageous position, pile-head covers, as shown in Fig. 131, are used. The centre of cast steel of steel, the inside of the recess will be cast to suit various pile diameters as when of pile-head covers and recesses made. The regular sizes for this work are 11½ and 13½ inches diameter. We have a variety of patterns in stock.

Write for prices, stating sizes.

Fig. 132. Pile-head Cover

PILE POINTS OR "SHOES"

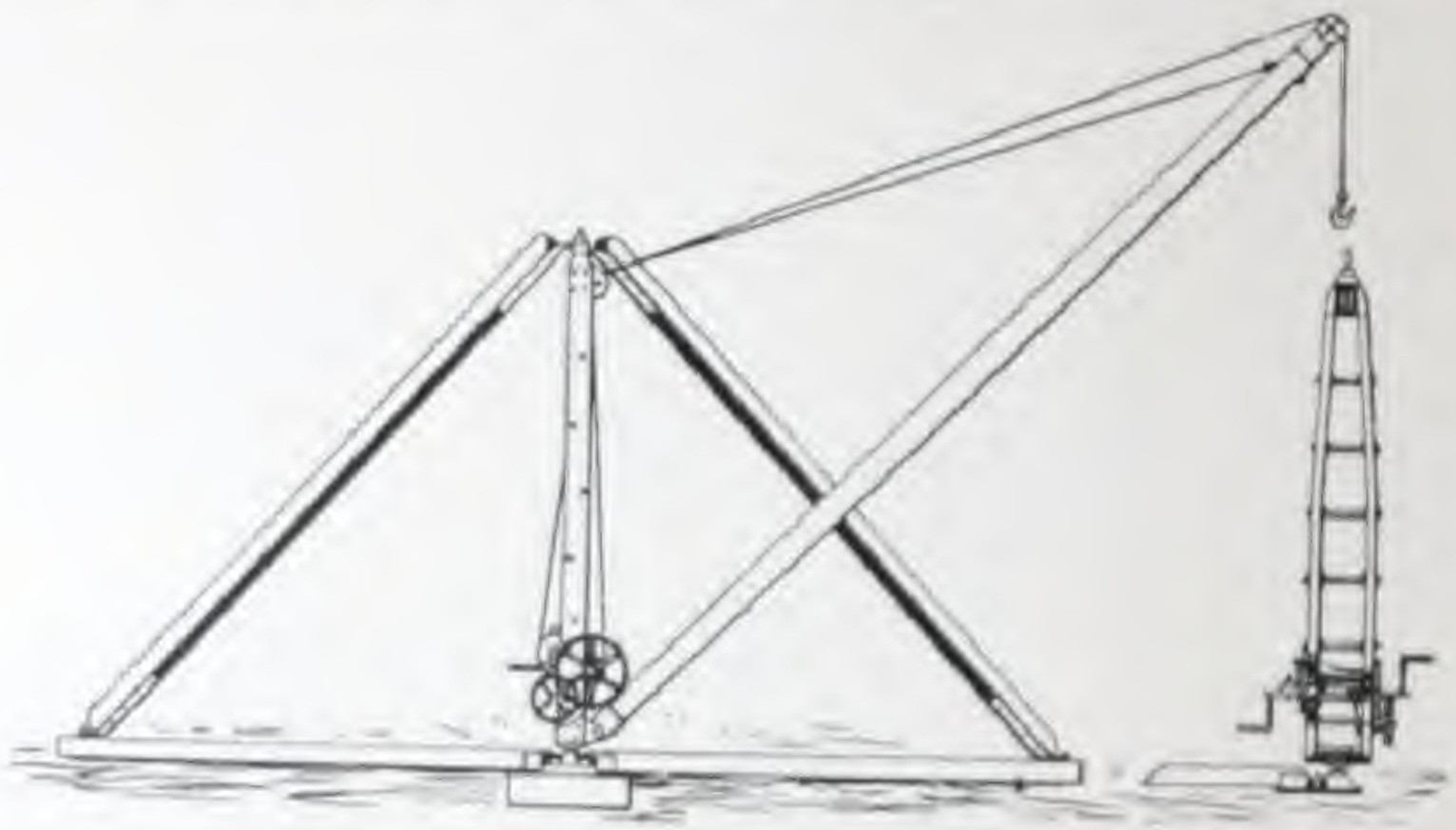
Fig. 133. Pile Shoe

The points are of great importance in driving piles in hard and sand they prevent the piles from becoming knocked up or waste of the great pressure. The shoes shown in Fig. 133 is usually made up to 16 or 20 in diameter, with proportion weights of 50, 70 and 100 lbs. but other sizes can be manufactured on request. All shoes are fitted on the head of bearing shaft. Of course, those sizes will be for piles of much larger size, as the piles should be squared to fit in the shoes.

Enquiries for any sizes of pile-shoes will gladly be attended to request.

DERRICKS

We can supply iron-work for any type of contractors' or builders' derricks, especially of the Scotch and Stiff-Leg design. We make up special steel-angle derricks for use in steel erection and other heavy work.



No. 141—Scotch Derrick—(Hand Power).

SPECIFICATIONS FOR SCOTCH DERRICK

Capacity, Tons	Length Boom, Ft.	Weight, Lbs.	Rope Equipment			
			Diam. In.	Hoist, Ft.	Boom, Ft.	Total Feet
¾	25	2300	½	80	45	125
1	25	2400	½	130	55	185
1½	30–35	2700	⅝	140	65	205
2	35–40	3000	⅝	150	75	225
3	40–45	4200	¾	150	75	225
4	40–45	4800	¾	150	75	225
5	45–50	5700	¾	150	110	260

HORSE POWER OF AN ENGINE

a = area of piston in square inches.

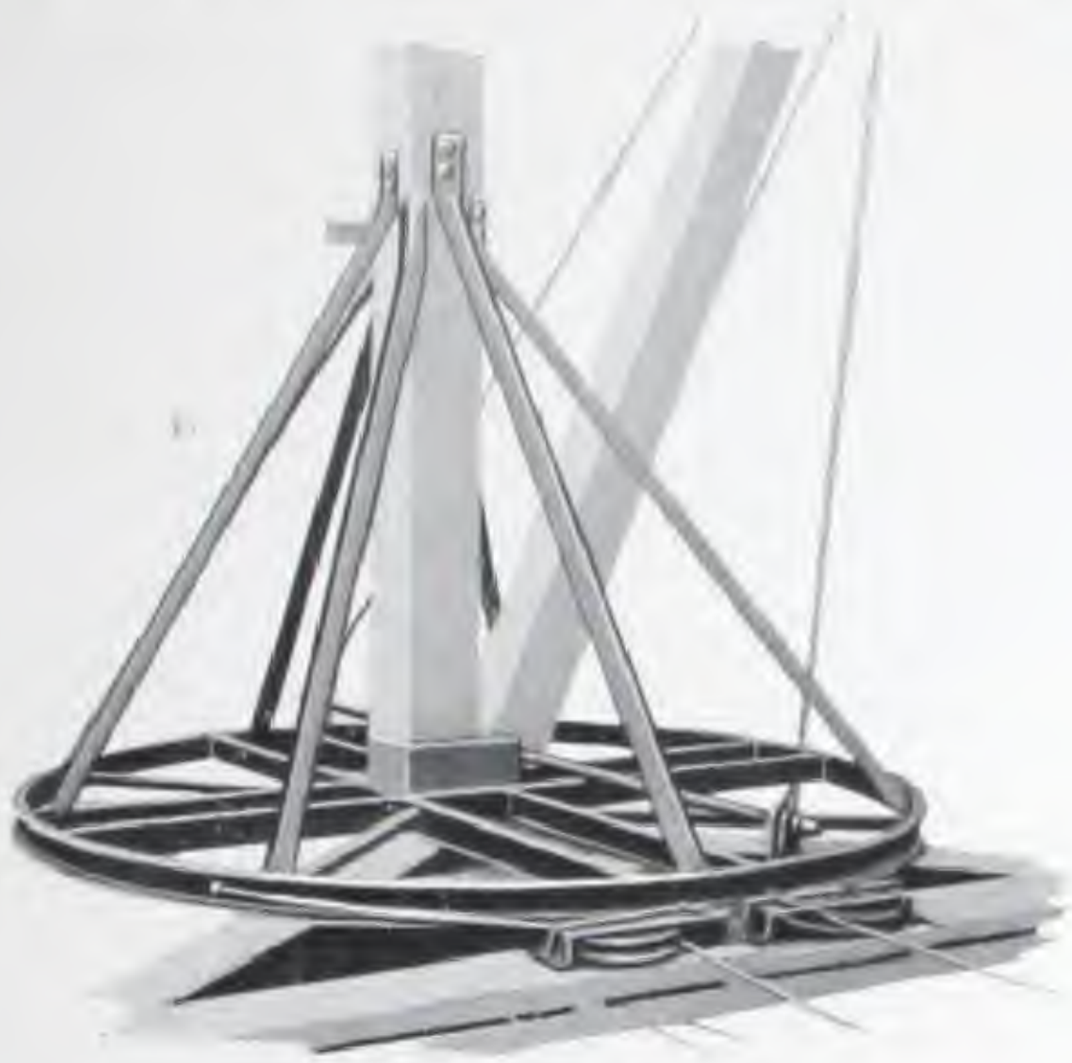
p = mean pressure of the steam on the piston per square inch.

v = velocity of piston per minute in feet.

Then H. P. $= \frac{a \times p \times v}{33000}$

DERRICK BULL-WHEELS

The bull-wheel, for swinging booms on power derricks is a most valuable feature in any derrick, and will save enough time and labor to pay for itself several times in a season. It may be attached, without changes, to any power derrick mast bottom.



No. 142—Derrick Bull-Wheel

It takes time and money to swing a derrick by hand with men pulling on the tag line when teams, cars or men are waiting for the derrick.

With a bull-wheel and derrick swinging engine, the engineer can lift the load and swing it into place in the time it takes to do the lifting only.

The accompanying illustration shows a 12-foot bull-wheel and gives a good view of the braeing to mast and boom.

STONE GRABS AND TONGS

We can supply promptly stone-setters' grabs or stone tongs of any capacity merely upon your specification of opening and maximum capacity. No. 143 shows a stone-setters' grab, which can be furnished suitable for any kind of stone. A common style of stone tong is shown by No. 144. Prices quoted upon request.

No. 143—Stone-Setters' Grab

No. 144—Stone Tongs

ORE BUCKETS

Ore buckets can be supplied in either the self-dumping style or in the regular side-lug type; in the former the bale is attached below the center of gravity and in the latter it is fixed to the bucket above the center of gravity.

Self-Dumping Type—The center-swing type of bucket for easy dumping is shown by No. 145. It is constructed throughout of $\frac{3}{16}$-inch steel, except in the 1½-cubic-yard size, in which the bottom is ¼-inch steel. The bail and trunnions are heavy, while the catch is strong, reliable and simple in operation. Specifications for this type of bucket follow:

No. 145 (At Right)—Self-Dumping Ore Bucket

Capacity	Diam. Top, In.	Diam. Bottom, In.	Depth, In.	Weight, Lbs.
8 Cubic Feet	26	23	27	240
10 Cubic Feet	29	25	30	300
½ Cubic Yard	32	27	35	360
¾ Cubic Yard	36	31	40	430
1 Cubic Yard	39	34	45	500
1½ Cubic Yards	45	40	50	650

Regular Type—The sides and bottom of this style of bucket, illustrated by No. 146, are made of $\frac{3}{16}$-inch steel, pressed into shape by hydraulic pressure. The sides have welded or countersunk-riveted seams to prevent catching upon sides of shaft. Banded around top. This bucket can be constructed in any size to suit any specification. Estimates furnished on request.

No. 146 (At Left)—Regular Style Ore Bucket

CONTRACTORS' BUCKETS

We can construct self-dumping and self-righting contractors' buckets to suit individual requirements. Steel plate, $\frac{1}{4}$-inch, is used, securely riveted. The

No. 147—Self Dumping Bucket

No. 148—Self-Righting Bucket

illustrations show both types of contractors' buckets, self-dumping and self-righting, in typical patterns. Write for prices giving full particulars as to height-diameter, capacity, etc.

DERRICK SKIPS

Derrick skips for handling stone, clay, earth, etc., can be supplied in either steel or wood construction and in any design required. The skip shown in No. 149 is constructed of well-ironed two-inch oak in any capacity specified, usually one

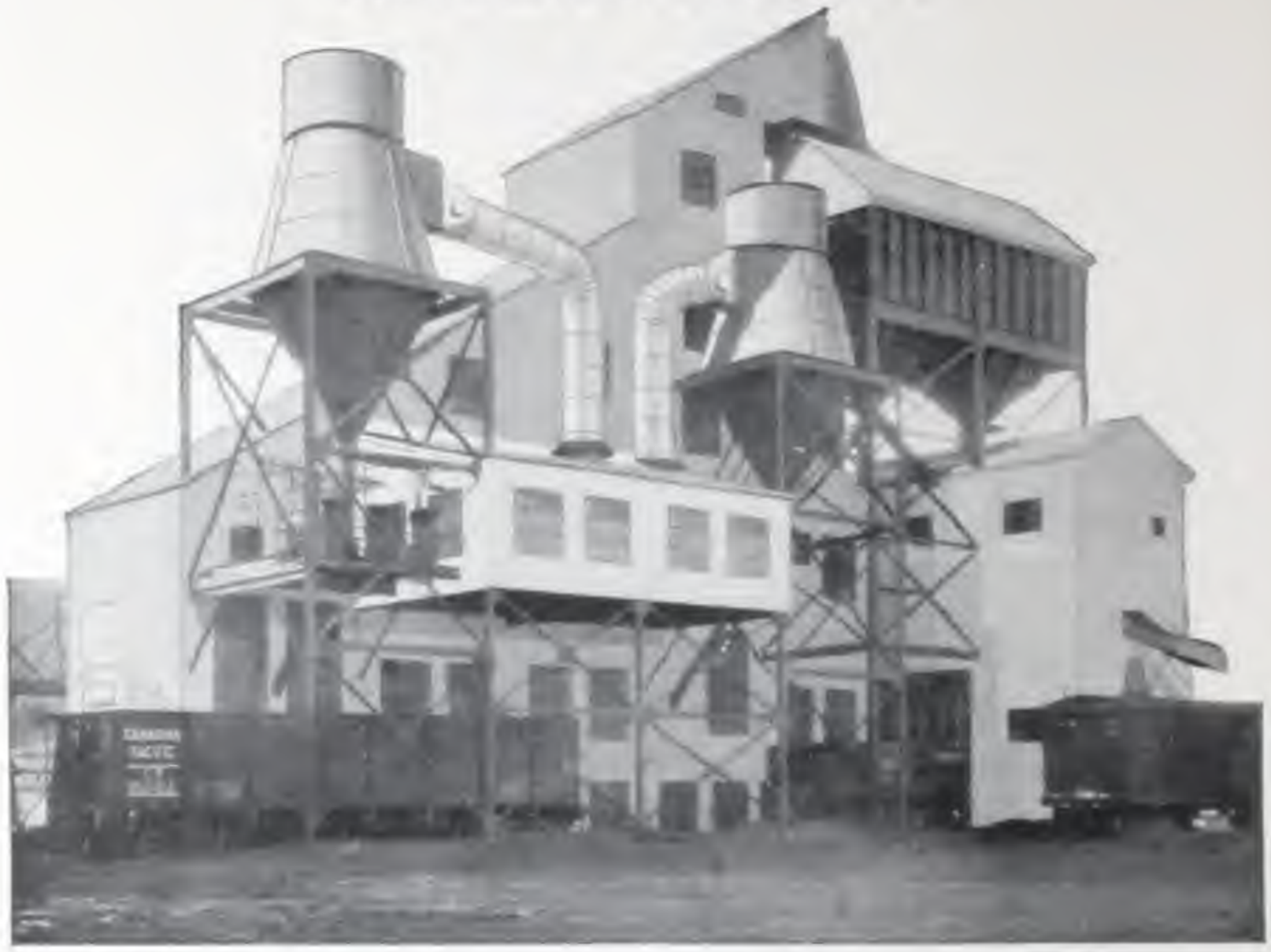
No. 149—Wooden Derrick Skip

No. 150—Steel Derrick Skip

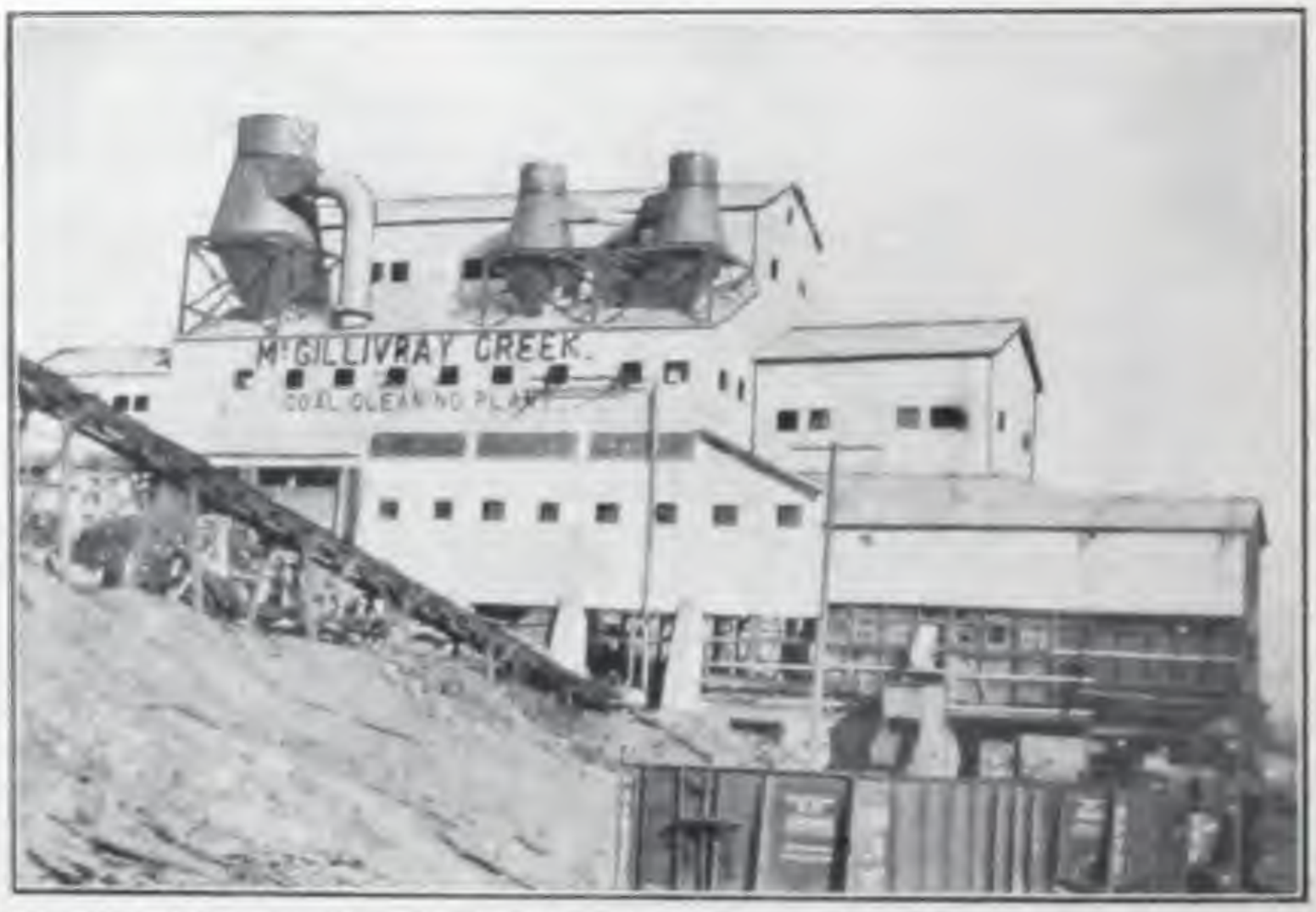
or two cubic yards. No. 150 illustrates the steel derrick skip of which the standard capacity is 35 cubic feet. The box is constructed of No. 8 steel, well riveted and braced, with angle corners and flat top band, and supported by three $\frac{1}{2}$-inch diameter chains. Heavier skips of any size can be supplied on order.

When ordering or asking for prices specify full dimensions, thickness of plate or wood desired, where chains are to be attached, etc.

COAL-MINING EQUIPMENT



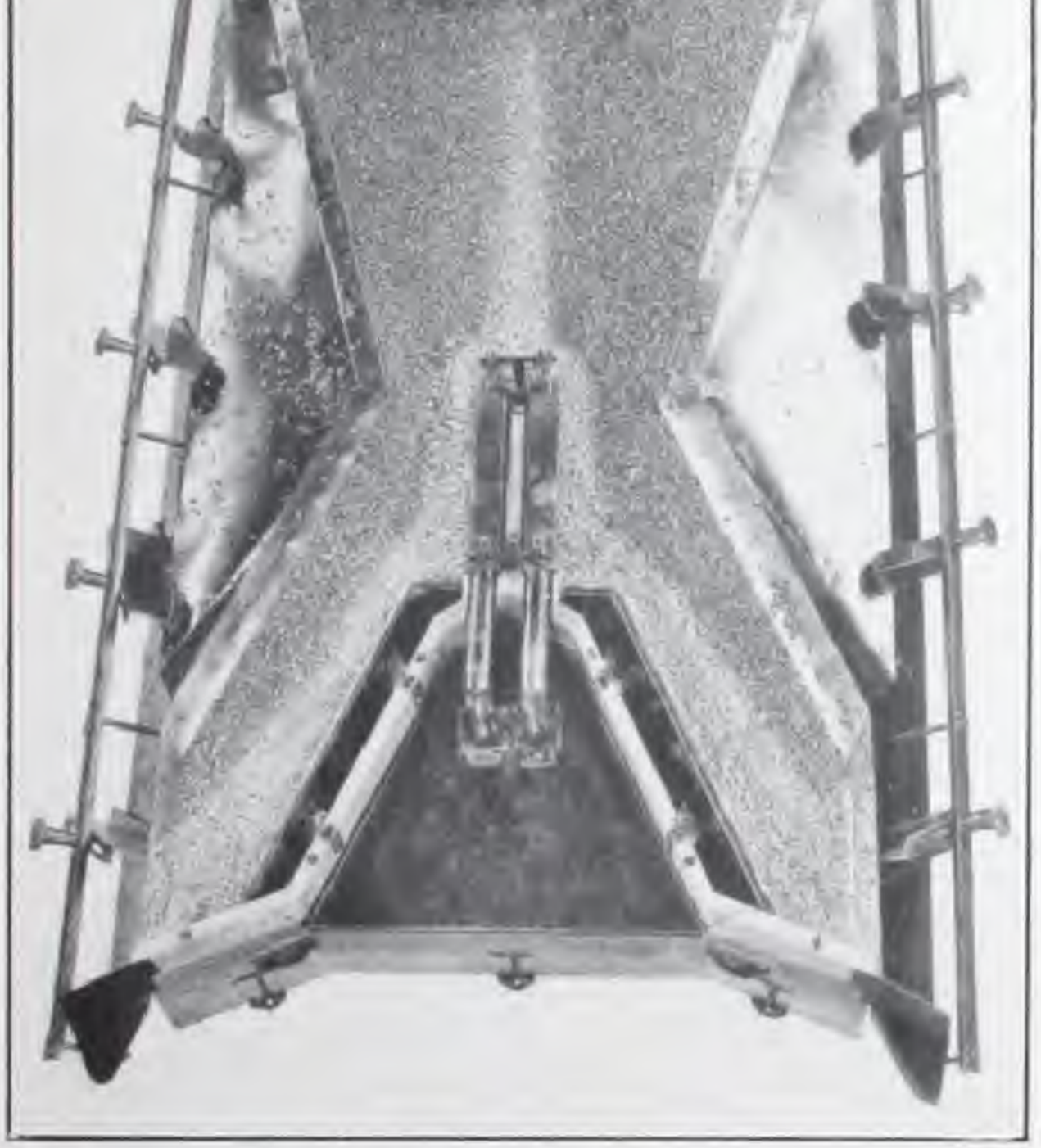
No. 151—Steel Tipple and Pneumatic Cleaning Plant of the International Coal and Coke Company, Coleman, Alta



No. 152—McGillivray Creek Coal and Coke Co.'s Steel Tipple and Pneumatic Cleaning Plant at Coleman, Alta.

We design, fabricate and erect coal-mining buildings and equipment of all kinds, including pneumatic tables for coal-cleaning, Marcus screens, rotary dumps,

shaking, rotary and bar screens, weigh pans, pan, belt, scraper and Eickhoff conveyors, elevators, belt and chain car irons, steel car ends, steel rock cars, spiral separators, etc. We specialize particularly in all-steel coal tipples and have done work for many of the prominent Western Canadian mines including Regal, Luscar, Mercoal, Cadomin, International, McGillivray and West Canadian Collieries.



No. 153—Air-Cleaning Y- Table.

The illustration above conveys a good idea of the definite stream-line between rock and coal on the pneumatic table. These tables are manufactured by us at Winnipeg under license from the American Coal Cleaning Corporation, Welch, W.Va. Three Y- and three SJ-tables are installed in the International plant, five Y- and one SJ-table at the McGillivray plant, and two SJ-tables at the West Canadian Collieries' Bellevue plant.

MINE CARS

All-steel dump cars for carrying stone, clay, earth, cinders, ashes, coal, concrete, etc., can be supplied according to specifications. These cars may have rocker or rotary dump arrangement.

No. 154—Rocker Dump Car

No. 155—Rotary Dump Car

The rocker type of side-dump car is seen in No. 154 above, in dumping position. The dumping arrangement is positive and easily worked, none of the contents falling between the rails. Box can be held in a starting position for convenience in loading.

A swing-last dump car of rotary type is illustrated in dumping position in No. 155. The body is supported on a wrought steel turn-table and is securely locked to the truck by a cradle catch; when unhooked, body is swung on the turn-table, permitting the load to be dumped at the end or either side.

All cars are made of ¼-inch steel plate riveted. We are prepared to design and manufacture all steel cars for any purpose whatever. Wheels, axles, trucks, etc., will also be furnished without the cars if wanted. We have a number of patterns of car wheels in stock and can promise quick delivery of material.

For coal mines we can supply complete sets of irons for use with wooden cars, or also manufacture steel plate ends for wooden cars.

FIELD STOVES

Field stoves or salamanders are used by construction, water supply companies, and others, for heating head on construction work, for heating buildings under construction, and for similar purposes.

The sides of the stoves are of No. 14-gauge plate, riveted; the grate is of ½-inch cast iron plate, perforated.

Field stoves may be supplied with or without handle, as desired.

All sizes of field stoves can be made to order, Other patterns are available if desired.

In writing for prices, state sizes required and specify preference as to patterns.

No. 156 (11 1-2)—Field stove or salamander

COAL AND ASH HANDLING EQUIPMENT

[illegible]

Fig. [illegible]

[illegible]

SEAMLESS BOILER TUBES

WEIGHTS AND DIMENSIONS

External Diam. In.	MINIMUM STANDARD THICKNESS		Nominal Weight per Foot in Pounds					
			STANDARD THICKNESS		ONE EXTRA WIRE GAUGE		TWO EXTRA WIRE GAUGES	
	Birmingham Wire Gauge	Inches	Exact Theoretical Weight	Approx. Manufact'g Weight	Exact Theoretical Weight	Approx. Manufact'g Weight	Exact Theoretical Weight	Approx. Manufact'g Weight
1	13	.095	.92	1.06	1.04	1.20	1.13	1.30
1¼	13	.095	1.17	1.34	1.33	1.53	1.45	1.67
1½	13	.095	1.42	1.63	1.62	1.86	1.77	2.03
1¾	13	.095	1.68	1.93	1.91	2.20	2.09	2.40
2	13	.095	1.93	2.22	2.20	2.53	2.41	2.77
2¼	13	.095	2.19	2.52	2.49	2.86	2.73	3.14
2½	12	.109	2.78	3.20	3.05	3.51	3.39	3.90
2¾	12	.109	3.07	3.53	3.37	3.87	3.74	4.30
3	12	.109	3.37	3.87	3.69	4.24	4.10	4.71
3¼	11	.120	4.01	4.61	4.46	5.00	4.90	5.63
3½	11	.120	4.33	4.98	4.82	5.54	5.30	6.09
4	10	.134	5.53	6.36	6.09	7.00	6.76	7.77
4½	10	.134	6.25	7.18	6.88	7.91	7.64	8.78
5	9	.148	7.67	8.82	8.52	9.79	9.27	10.66
6	8	.165	10.28	11.82	11.19	12.86	12.57	14.45

External Diam. In.	MINIMUM STANDARD THICKNESS		THREE EXTRA WIRE GAUGES		FOUR EXTRA WIRE GAUGES	
			Exact Theoretical Weight	Approx. Manuf'g Weight	Exact Theoretical Weight	Approx. Manuf'g Weight
	Birmingham Wire Gauge	Inches				
1	13	.095	1.24	1.43	1.35	1.55
1¼	13	.095	1.60	1.84	1.74	2.00
1½	13	.095	1.95	2.24	2.14	2.46
1¾	13	.095	2.31	2.66	2.53	2.91
2	13	.095	2.67	3.07	2.93	3.37
2¼	13	.095	3.02	3.47	3.32	3.82
2½	12	.109	3.72	4.28	4.12	4.74
2¾	12	.109	4.11	4.72	4.56	5.24
3	12	.109	4.51	5.18	5.00	5.75
3¼	11	.120	5.44	6.25	5.98	6.78
3½	11	.120	5.88	6.76	6.38	7.33
4	10	.134	7.34	8.44	8.23	9.46
4½	10	.134	8.30	9.54	9.32	10.71
5	9	.148	10.40	11.95	11.23	12.91
6	8	.165	13.58	15.61	14.65	16.84

Boiler tubes to special specifications, if desired.

BOILER TUBES

STANDARD DIMENSIONS

Outside Dia.		Thickness of Metal B.W.G.	Thickness of Metal Decimal Parts of an Inch	Circumference		Transverse Areas Sq. Ins.			Lengths Tubes can be Cut from Bars		Weight per Foot
Exact	Nearest 1/16			Exact	Nearest 1/16	External	Internal	Metal	Exact	Nearest 1/16	
1	1	13	.095	3.142	3 3/16	.785	.515	.270	20ft 8in	20ft 6in	2.18
1 1/4	1 1/4	13	.095	3.927	3 15/16	1.227	.959	.268	16ft 1in	15ft 11in	2.68
1 1/2	1 1/2	13	.095	4.712	4 11/16	1.767	1.496	.271	13ft 5in	13ft 3in	3.19
1 3/4	1 3/4	13	.095	5.498	5 7/16	2.405	2.155	.250	11ft 6in	11ft 4in	3.68
2	2	13	.095	6.283	6 3/16	3.142	2.874	.268	10ft 1in	9ft 11in	4.18
2 1/4	2 1/4	13	.095	7.069	6 15/16	3.976	3.719	.257	8ft 11in	8ft 9in	4.68
2 1/2	2 1/2	13	.095	7.854	7 13/16	4.909	4.657	.252	8ft 1in	7ft 11in	5.18
2 3/4	2 3/4	13	.095	8.639	8 5/8	5.940	5.685	.255	7ft 4in	7ft 2in	5.68
3	3	13	.095	9.425	9 7/16	7.069	6.812	.257	6ft 8in	6ft 6in	6.18
3 1/4	3 1/4	13	.095	10.210	10 3/16	8.296	8.039	.257	6ft 1in	6ft 0in	6.68
3 1/2	3 1/2	13	.095	10.996	10 15/16	9.621	9.363	.258	5ft 7in	5ft 6in	7.18
3 3/4	3 3/4	13	.095	11.781	11 13/16	11.045	10.792	.253	5ft 2in	5ft 1in	7.68
4	4	13	.095	12.566	12 9/16	12.566	12.304	.262	4ft 10in	4ft 9in	8.18
4 1/2	4 1/2	13	.095	14.137	14 1/8	15.904	15.643	.261	4ft 3in	4ft 2in	9.18
5	5	13	.095	15.708	15 11/16	19.635	19.373	.262	3ft 10in	3ft 9in	10.18
6	6	13	.095	18.850	18 13/16	28.274	28.012	.262	3ft 2in	3ft 1in	12.18
7	7	13	.095	21.991	21 15/16	38.484	38.222	.262	2ft 8in	2ft 7in	14.18
8	8	13	.095	25.133	25 1/8	50.265	50.003	.262	2ft 3in	2ft 2in	16.18
9	9	13	.095	28.274	28 1/4	63.617	63.354	.263	2ft 0in	1ft 11in	18.18
10	10	13	.095	31.416	31 3/8	78.540	78.278	.262	1ft 9in	1ft 8in	20.18
11	11	13	.095	34.558	34 9/16	95.033	94.770	.263	1ft 7in	1ft 6in	22.18
12	12	13	.095	37.699	37 11/16	113.098	112.835	.263	1ft 5in	1ft 4in	24.18
13	13	13	.095	40.841	40 13/16	132.732	132.470	.262	1ft 3in	1ft 2in	26.18
14	14	13	.095	43.982	43 15/16	153.938	153.676	.262	1ft 2in	1ft 1in	28.18
15	15	13	.095	47.124	47 1/8	176.715	176.452	.263	1ft 1in	1ft 0in	30.18

We carry in stock and can supply prompt delivery for manufacture of locomotive boiler tubes.

Note.—In estimating effective steam-heating or evaporating surface of tubes, the surface in contact with air or gases of combustion, according to manner of application, as whether internal or external, is to be the basis taken. For heating liquids by steam, superheating steam, or evaporating, heat from one liquid to one side to another, outside surfaces of tubes to be considered. Divide lengths (ft. 14, 15, 16 and) 20 feet.

HORSE-POWER OF ANY BOILER

It is general practice to base the computation of the horsepower of ordinary boilers on the following rule:

Estimate the total heating surface in square feet. This is usual to the surface area of all the tubes, plus two-thirds the surface of the shell and both tube sheets minus the area of the tube holes. This allow one horsepower for every fifteen square feet of heating surface in horizontal tubular boilers and one horsepower for every 11½ square feet of heating surface in water tube boilers.

STANDARD WROUGHT MERCHANT PIPE
FOR STEAM, WATER, GAS AND OIL

Nominal Inside Diam., In.	Thickness, In.	Nominal Wt. per Ft., Lbs.	No. of Threads per In. of Screw	Nominal Inside Diam., In.	Thickness, In.	Nominal Wt. per Ft., Lbs.	No. of Threads per In. of Screw
1/8	.068	.24	27	3 1/2	.226	9.00	8
1/4	.088	.42	18	4	.237	10.66	8
3/8	.091	.56	18	4 1/2	.246	12.34	8
1/2	.109	.84	14	5	.259	14.50	8
3/4	.113	1.12	14	6	.280	18.76	8
1	.134	1.67	11 1/2	7	.301	23.27	8
1 1/4	.140	2.24	11 1/2	8	.322	28.18	8
1 1/2	.145	2.68	11 1/2	9	.344	33.70	8
2	.154	3.61	11 1/2	0	.366	40.06	8
2 1/2	.204	5.74	8	1	.375	45.02	8
3	.217	7.54	8	2	.375	49.00	8

Stock lengths of merchant pipe are 19, 21 and 22 feet.

"XX" STRONG PIPE

Size, In.	Actual Outside Diam., In.	Nominal Inside Diam., In.	Thickness, In.	Nominal Wt. per Ft., Lbs.	Size, In.	Actual Outside Diam., In.	Nominal Inside Diam., In.	Thickness, In.	Nominal Wt. per Ft., Lbs.
1/2	.84	.244	.298	1.70	3 1/2	4.00	2.716	.642	22.75
3/4	1.05	.422	.314	2.44	4	4.50	3.136	.682	27.48
1	1.315	.587	.364	3.65	4 1/2	5.00	3.56	.72	32.53
1 1/4	1.66	.885	.388	5.20	5	5.563	4.063	.75	38.12
1 1/2	1.90	1.088	.406	6.40	6	6.625	4.875	.875	53.11
2	2.375	1.491	.442	9.02	7	7.625	5.875	.875	62.38
2 1/2	2.875	1.755	.560	13.68	8	8.625	6.875	.875	71.62
3	3.50	2.284	.608	18.56					

Stock lengths of "XX" Pipe are 19, 21 and 22 feet. This class of pipe is always shipped, plain ends, unless otherwise specified.

The outside diameters of "XX" pipe are the same as standard, the extra thickness decreasing the inside diameter.

CAST IRON PIPE

We manufacture cast iron specials of all classes, in elbows, tees, bends, etc., and will send estimates on receipt of specifications.

No. 158—Halfway Bridge, Fabricated and in Process of Erection by the Manitoba Bridge and Iron Works, Limited

RAILWAY TURNOUTS

We are manufacturers of complete lines of frog and switch material and diamonds for railway, industrial and mine work. The superior merit of our work is attested to by the fact that we build for both the Canadian National Railways and the Canadian Pacific Railway.

The illustration herewith shows the different parts that enter into a complete turnout. The gauge may vary from standard railway gauge down to the smallest industrial track, and the weight of the rails may range from 100 lbs. per yard, as used on the heaviest railway sections, down to 12-lb. rail used in industrial plants.

No. 159—Railway Turnout

Switches may be stub, split, spring or automatic; they may be operated by ground throws or switch stands. They can be supplied complete with riser plates, braces, bridle bars, switch rods, etc., in the most complicated types for heavy railroad traffic, or in the simplest style for periodic light traffic.

Guard rails may be plain bent for light rail, or bent and planed for heavy rail, and spiked to ties, or bent, planed and chamfered for heavy rail, and bolted to the main rail with cast iron adjustable separators.

Frogs may be bolted rigid, spring or forged for light rail, and may be made with cast manganese centers for heavy rail.

Railroad crossings or diamonds are made to any angle, of strong rigid construction. Flangeways of crossing track are planed through the heads of the rails, leaving webs and bases uncut. The filling material used for diamonds is forged wrought iron, and heavy rolled straps are used for the inside and outside corners.

Bolts are from $\frac{7}{8}$-inch to $1\frac{1}{8}$-inch diameter, depending on the size of rail, and are furnished with head and nut locks.

Crossings can be made in any number, of any rail, of any angle, with or without curves.

We make up tongue switches and mates for street railways, for use on paved streets. To ensure length of wear, these are made of special material.

We also manufacture Jackson switch stands, both low and high type, as well as ground throws, both hand and automatic.

RAILWAY FROGS

No. 680. Right Hand Cast Steel Frog.

No. 681. Right Hand Cast Steel Frog.

No. 681½. Right Hand Cast Steel Frog, Showing Method of Bolting Wing Rail.

CONCRETE REINFORCING BARS

Concrete reinforcing bars can be rolled in the shapes shown below, to any specification, structural, intermediate or hard grade, and in lengths up to eighty feet. For weights of reinforcing, see table of Rounds and Squares, pages 25 and 26.

No. 162—*Plain Round*

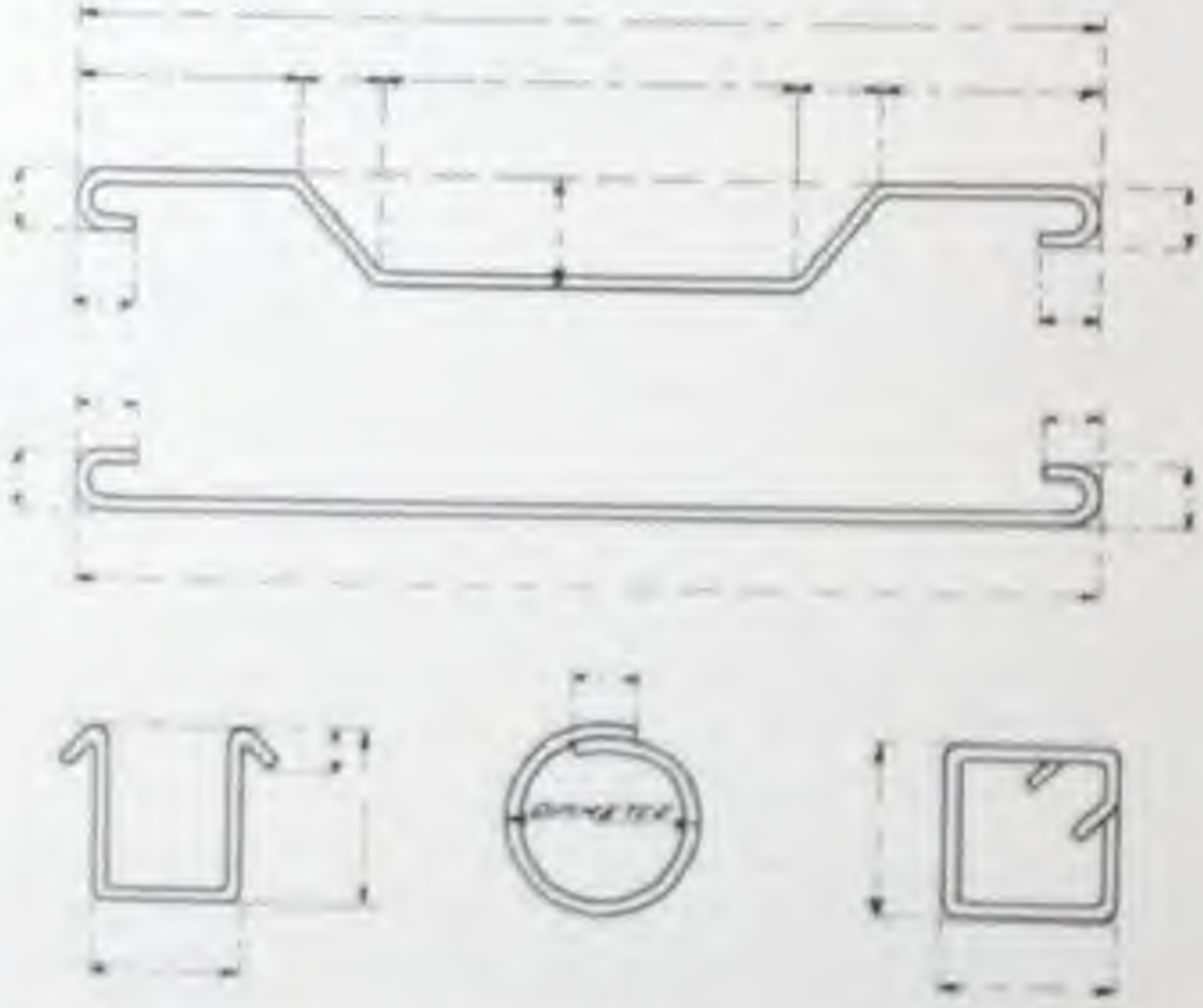
No. 163—*Plain Square*

No. 164—*Cold Twisted*

No. 165—*Deformed Round or Square*

Our reinforcing bar stock of plain and deformed bars is very complete and our equipment enables us to bend reinforcing to any shape. We can make very prompt shipments from stock. Concrete specialties such as bar chairs, spacers, ties, inserts, etc., can be supplied to meet any requirements. We can also furnish wire mesh, expanded metal wire, small channels, etc.

It is to the contractor's advantage to have all reinforcing bent to shape in the shops. For the commoner different types of bars, the dimensions as shown in the diagram below, should be given. In ordering bent reinforcement, always give dimensions from outside to outside of bars.



No. 166—*Dimensions Required when Ordering Reinforcing*

We can also supply spirals, in ordering which, give size of wire, outside diameter of core, pitch or distance centre to centre of wire, overall length and number of spacers.

REINFORCED CONCRETE DESIGN

The design of reinforced concrete structures comes into the province of the civil engineer, and the following notes are intended to show briefly the principles underlying the design of beams, columns, floors, etc., and to indicate the manner in which the requirements of the Provincial Building Regulations are met.

STANDARD NOTATION

The following symbols are recommended for use in all calculations:

a. Rectangular Beams.

f_s = Tensile unit stress in steel.

f_c = Compressive unit stress in concrete.

f_v = Shearing unit stress in concrete.

E_s = Modulus of elasticity of steel.

E_c = Modulus of elasticity of concrete.

$n = \frac{E_s}{E_c}$

M = Bending moment in inch-lbs.

A_s = Steel area.

b = Breadth of beam.

d = Depth to centre of steel.

$p = \frac{A_s}{bd}$ = Ratio of steel area to effective area of concrete.

k = Ratio of depth of neutral axis to depth d.

j = Ratio of lever arm of resisting couple to depth d.

$R = \frac{M}{bd^2}$ = Resisting moment per sq. in.

b. T-Beams.

f_s = Tensile unit stress in steel.

f_c = Compressive unit stress in concrete.

f_v = Shearing unit stress in concrete.

E_s = Modulus of elasticity of steel.

E_c = Modulus of elasticity of concrete.

$n = \frac{E_s}{E_c}$

M = Bending moment in inch-lbs.

A_s = Steel area.

b = Breadth of flange.

b' = Breadth of stem.

d = Depth to centre of steel.

d' = Depth of flange.

$p = \frac{A_s}{bd}$ = Ratio of steel area to effective area of concrete.

k = Ratio of depth of neutral axis to depth d.

j = Ratio of lever arm of resisting couple to depth d.

$R = \frac{M}{bd^2}$ = Resisting moment per sq. in.

c. Beams Reinforced for Compression.

p' = Ratio of compression steel to effective area of concrete.

A'_s = Area of compression steel.

f'_s = Compressive unit stress in steel.

f'_c = Unit stress in concrete at level of compression steel.

f'_v = Unit compressive stress in concrete.

d. Floor Slabs and Web Reinforcement.

V = Total shear.

v = Unit shear resisting stress in concrete.

v' = Shearing unit stress.

s = Bond stress per unit surface of bar.

u = Unit bond stress = $\frac{V}{\Sigma o j d}$

Σo = Sum of perimeters of bars.

j = Ratio of lever arm of resisting couple to depth d.

d = Depth to centre of steel.

A_v = Area of web reinforcement.

$p_v = \frac{A_v}{bs}$ = Ratio of web reinforcement to concrete.

f_v = Unit tensile stress in web reinforcement.

s' = Horizontal spacing of bent-up bars.

e. Columns.

A = Total cast area.

A_c = Area of concrete.

A_s = Area of steel.

P = Total safe load.

FORMULAS

The formulas which follow are for working loads and assume a straight line variation of stress to deformation of concrete in compression; tension in the concrete is neglected.

(a) Rectangular Beams—

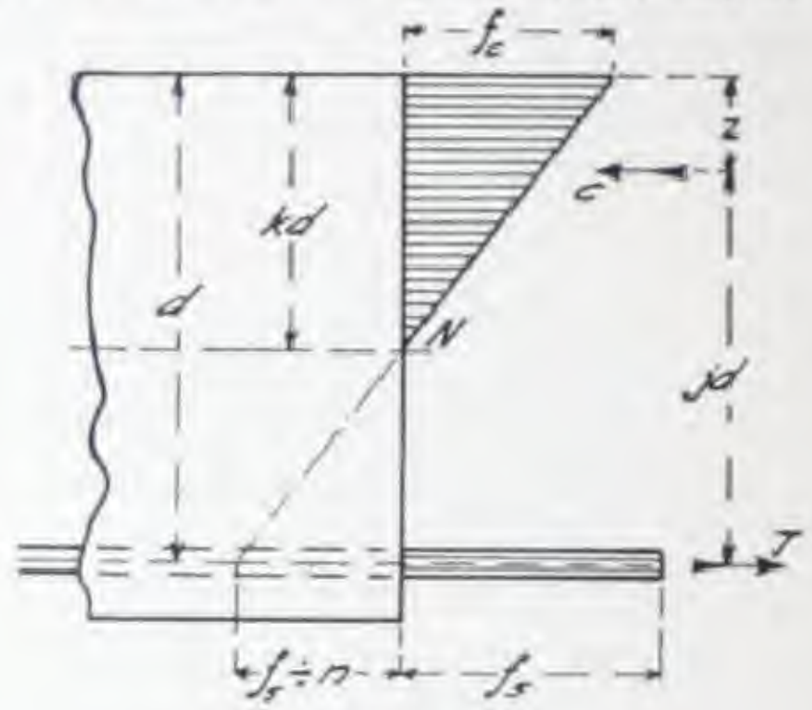
Position of neutral axis,

$$k = \sqrt{2pn + (pn)^2} - pn, \quad k = \frac{nf_c}{nf_c + f_s} \tag{1}$$

Arm of resisting couple,

$$j = 1 - \tfrac{1}{3}k \tag{2}$$

[For $f_s = 15{,}000$ to $16{,}000$ and $f_c = 600$ to 650, j may be taken at $\frac{7}{8}$.]



No. 167

Fiber stresses,

$$f_s = \frac{M}{A_s jd} = \frac{M}{pjbd^2} \tag{3}$$

$$f_c = \frac{2M}{jkbd^2} \tag{4}$$

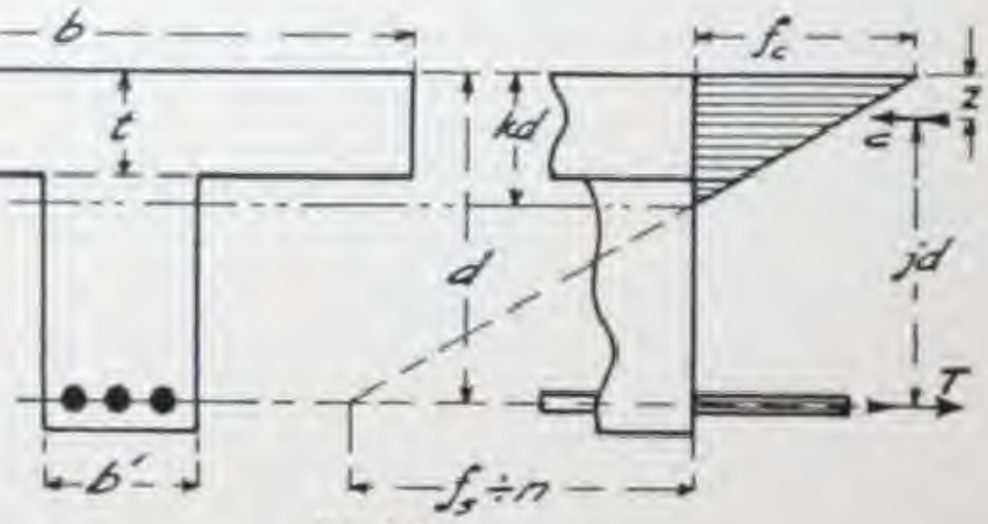
If constant $K = \frac{1}{2}f_c\, kj$ or $pf_s j$,

$$M = Kbd^2 \tag{5}$$

Steel ratio, for balanced reinforcement, (6)

$$p = \frac{\frac{1}{2}}{\frac{f_s}{f_c}\left(\frac{f_s}{nf_c} + 1\right)} \tag{7}$$

(b) T-Beams—



No. 168

CASE I. *When the neutral axis lies in the flange*, use the formulas for rectangular beams.

CASE II. *When the neutral axis lies in the stem.*
The following formulas neglect the compression in the stem.

Position of neutral axis,

$$kd = \frac{2ndA_s + bt^2}{2nA_s + 2bt} \tag{8}$$

Position of resultant compression,

$$z = \frac{3kd - 2t}{2kd - t} \cdot \frac{t}{3} \tag{9}$$

Arm of resisting couple,

$$jd = d - z. \tag{10}$$

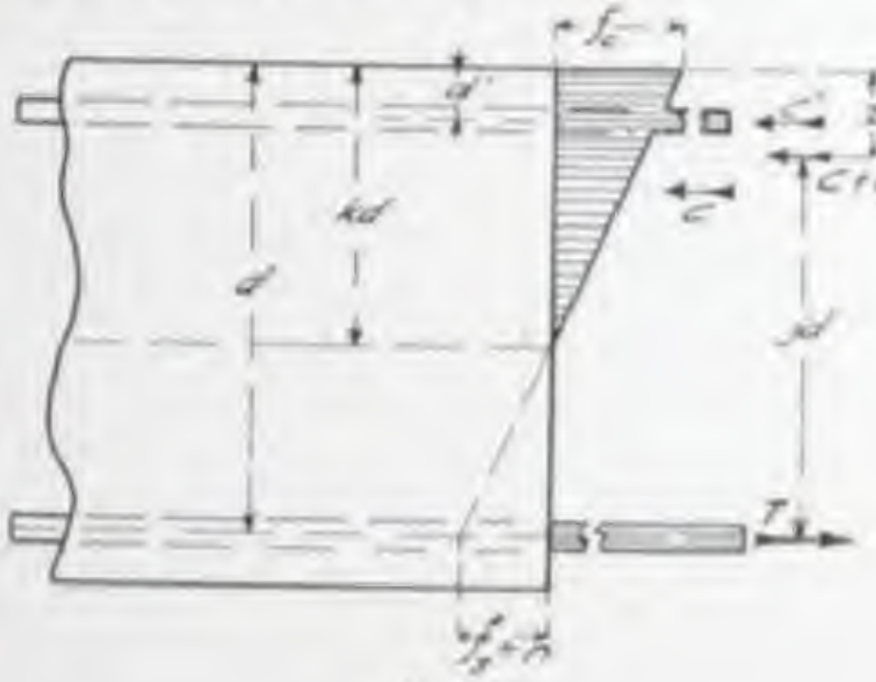
Fiber stresses,

$$f_s = \frac{M}{A_s jd} \tag{11}$$

$$f_c = \frac{Mkd}{bt(kd - \frac{1}{2}t)jd} = \frac{f_s}{n} \cdot \frac{k}{1-k} \tag{12}$$

[For approximate results, the formulas for rectangular beams may be used.]

(c) Beams Reinforced for Compression—



No. 169

Position of neutral axis,

$$k = \sqrt{2n\left(p + p'\frac{d'}{d}\right) + n^2(p+p')^2} - n(p+p') \tag{13}$$

Position of resultant compression,

$$z = \frac{\frac{1}{3}k^3 d + 2p'nd'\left(k - \frac{d'}{d}\right)}{k^2 + 2p'n\left(k - \frac{d'}{d}\right)} \tag{14}$$

Arm of resisting couple,

$$jd = d - z \tag{15}$$

Fiber stresses,

$$f_c = \frac{6M}{bd^2\left[3k - k^2 + \frac{6p'n}{k}\left(k - \frac{d'}{d}\right)\left(1 - \frac{d'}{d}\right)\right]} \tag{16}$$

$$f_c = \frac{M}{pjbd^2} = nf_c \frac{1-k}{k} \tag{17}$$

$$f_s' = nf_c \frac{k - \frac{d'}{d}}{k} \tag{18}$$

(d) **Shear, Bond, and Web Reinforcement** —

For rectangular beams,

$$v = \frac{V}{(pj)} \tag{19}$$

$$u = \frac{V}{jd\,\Sigma o} \tag{20}$$

[For approximate results, j may be taken at $\frac{7}{8}$.]

The stresses in web reinforcement may be estimated by means of the following formulae:

Vertical web reinforcement,

$$T_v = \frac{Vs}{jd} \tag{21}$$

Bars bent up at angles between 20° and 45° with the horizontal and web members inclined at 45°,

$$T_v = \frac{3}{4}\,\frac{Vs}{jd} \tag{22}$$

The same formulas apply to beams reinforced for compression as regards shear and bond stress for tensile steel.

For T-beams,

$$v = \frac{V}{(jd)} \tag{23}$$

$$o = \frac{V}{jd\,\Sigma o} \tag{24}$$

[For approximate results, j may be taken at $\frac{7}{8}$.]

(e) **Columns** —

Total safe load,

$$P = f_c(A_c + nA_s) = f_c A[1 + (n-1)p] \tag{25}$$

Unit stresses,

$$f_c = \frac{P}{A[1 + (n-1)p]} \tag{26}$$

$$f_s = nf_c \tag{27}$$

Bending Moments.—When the beam or slab is reinforced over its supports to take care of negative bending moments, the bending moment at the center of the span will be reduced. It is considered good practice to use the following values.

Floor slabs. M at *center* and at *supports* $= \frac{1}{12} wl^2$, where w represents the load per linear unit, and l the span length.

Beams. M at *center* and at *supports* $= \frac{1}{12} wl^2$ for interior spans, and, for end spans, $\frac{1}{10} wl^2$ for center and interior supports for both dead and live loads.

Working Stresses.—The following working stresses per sq. inch of net sections of members are used in connection with the Manitoba Standard Specifications for Steel Highway Bridges:—

Compression on gross section of members	16,000 lbs. per sq. in.
Tension on net section of members—	
Wrought-iron and structural steel	18,000 lbs. per sq. in.
Nickel steel	20,000 lbs. per sq. in.
Pins and rollers—	
Shear	12,000 lbs. per sq. in.
Bearing	24,000 lbs. per sq. in.
Extreme fibre stress in bending	18,000 lbs. per sq. in.
Bearing on pins	24,000 lbs. per sq. in.
Bearing on rollers	500 lbs. per lineal in. per in. of diameter of roller

Substituting in the foregoing formulæ the above working stresses, we obtain the following values of $\frac{l}{r}$ and $\frac{b}{t}$ for the various members:—

Members.	Kind of Steel.	$\frac{l}{r}$	$\frac{b}{t}$
Chords	Structural steel	100	12
	Nickel steel	120	14
Web members	Structural steel	120	14
	Nickel steel	140	16
Lateral struts	Structural steel	140	16
	Nickel steel	160	18
Portal struts	Structural steel	120	14
	Nickel steel	140	16

Fireproofing of Steel.—The following specification of composition [illegible] must be complied with by contractors:—

Flat plates.

Length in lineal ft.	Depth before coming of steel
1½ in. and under	½ in.
Between 1½ in. and 3½ in.	⅝ in.
3½ in. and over	¾ in.

Flat bars.

Length in lineal ft.	Depth in steel before steel
12 in. and under	½ in.
Between 12 in. and 20 in.	⅝ in.
20 in. and over	¾ in.

The lateral spacing of parallel bars should not be less than three diameters center to center, nor should the distance from the side of the beam be less than two diameters. The clear spacing between two layers of bars should not be less than 1½ inches. Where more than one layer is used, at least all the bars above the lower layer should be bent up and anchored beyond the edge of the support.

Tables of Safe Loads—These will be found to cover fairly well the ordinary requirements. The following examples are given only to illustrate the use of the constants K and p, on page 167.

EXAMPLE—Given a slab of 12-ft. span, simply supported, to carry a load of 180 lbs. per sq. ft., including its own weight.

$f_c = 700 \quad f_s = 18000 \quad n = 15$

$$M = \frac{wl^2}{8} = \frac{(180)(12)^2(12)}{8} = 38{,}880 \text{ in. lb.}$$

K and p may be found from the table for this combination on page 167.

$$K = \frac{M}{bd^2} = 113.1 \qquad d = \sqrt{M \div bk} \qquad p = 0.0072 \text{ and } A_s = pbd$$

Assuming b = 12 in.,

$$d = \sqrt{38880 \div (12 \times 113.1)} = 5.34 \text{ in.}$$

and $A_s = 0.0072 \times 12 \times 5.34 = 0.46$ sq. in.

Allowing for cover, the slab should be 6½ in. deep and the reinforcing may be ⅝-in. round rods at 7½-in. centers, which would be equivalent to 0.49 sq. in. per foot width. The weight of the slab in this case is 81 lbs., and the safe superimposed load = 180-82 = 98 lbs. per sq. ft.

EXAMPLE—Design a beam of rectangular section to span 30 feet. Total uniform distributed load is 100 lbs. per lineal foot. Beam simply supported.

$f_c = 750 \quad f_s = 18000 \quad n = 15 \quad v_1 = 40$

$$M = \frac{wl^2}{8} = \frac{(1000)(30)^2(12)}{8} = 1{,}350{,}000 \text{ in.-lb.}$$

From the table for this combination on page 167,
K = 125.7 p = 0.008 and $A_s = pbd$

Assuming b = 15 in.,

$$d = \sqrt{1350000 \div (15 \times 125.7)} = 26.75 \text{ or, say, } 27 \text{ in.}$$

and $A_s = 0.008 \times 15 \times 27 = 3.24$ sq. in.

Using three ⅞-inch and two 1-inch round rods, the total section will be 3.38 sq. in.

$$v = \frac{15000}{(15)(\frac{7}{8})(27)} = 42 \text{ lbs.}$$

When v = 42, provision for shear is unnecessary, but for practical reasons it is advisable to use stirrups at ends.

If the two 1-inch rods are bent up at 45°, beginning at a point 2 ft. 6 in. from the support, a better design will result.

The three ⅞-inch rounds remain in the bottom to develop the safe load stress.

$$\text{Bond stress } u = \frac{15000}{(8.25)(\frac{7}{8})(27)} = 77 \text{ lbs. per sq. in.}$$

This bond stress is within the safe limits and will not require special anchorage.

Slab Design.—Solid reinforced concrete slabs are designed for given loads by using the same formulae given for rectangular beams. A width of 12 inches is usually employed in proportioning the depth of percentage of steel. As a general rule, it is more economical to use the balancing values for f_c and p. After the point is reached beyond which the external fibre stress in the concrete controls in the design, it will be determined that the small increase in moment derived will not justify the cost of additional steel, which is added only for the purpose of lowering the neutral plane to prevent exceeding the maximum working value assigned to f_c.

For all slabs it is advisable to use temperature rods (round or square) to resist stresses perpendicular to the carrying reinforcement, to insure the slabs of cracks from shrinkage and temperature stresses, as well as to keep top to which carrying bars can be tied to preserve a given spacing.

The investigation of shear in solid slabs is seldom necessary except in the case of heavy concentrated loads. Continuous slabs should always be provided with sufficient steel extending over the supports to take negative moments. It is necessary practice to bend up one-half of the bars from each alternate panel, at approximately the one-fourth point, which gives a steel section for negative moment equal to that of the positive moment requirements at the centre of the panel.

Two-way Reinforced Slabs.—A series of panels distributed in two directions at right angles, and supported along four sides, should be made continuous over supports. In oblong panels the greatest length should not exceed 1½ times the least width. As a panel becomes oblong, the proportion of load carried by the longer span becomes rapidly less.

Let x = proportion of total load carried by shorter span.

l = length of longer span in feet.

b = breadth of panel or shorter span in feet.

Then $x = \frac{1}{\frac{l}{b}} - 0.35$

T- Beams.—In calculating the strength of T beams, advantage is taken of the floor slab, which must act as the compression flange of the member. To properly perform its function, a T beam must be poured monolithically with the floor slab, and the stem and flange securely tied together by means of bent rods, stirrups and cross reinforcement from the slab. The slab should be an integral part of the beam.

The thickness of the flange is fixed by the depth of the slab, but the distance to either side of the stem over which compression may be assumed to act is arbitrarily selected from the result of tests.

If T beams are simply supported at the ends, full advantage may be taken of the flange in resisting the compressive stress. The width of flange on either side of the web being taken at not more than six times the thickness in the calculations for compressive strength. If the beam is continuous at supports, a negative moment is developed which places the flange in tension and the web in compression and the latter becomes one of rectangular section. However, as only a short section of the beam is in compression at this point, it is suggested as permissible to use a higher unit compressive stress here than at the centre of the span, as (instead of 16%) being allowed. It is also permissible to consider the straight bars in the bottom of the beam as compressive reinforcement provided they are extended sufficient distance beyond the face of the support to develop their stress in bond. It is evident that in the multiplying T beam the moment should be taken at the rectangular section at the point farthest from the T section at the centre of the span. The web stresses and the limitation in shearing unit stress in bond governing the longitudinal reinforcement will probably be controlling factors in design.

Web Reinforcement.—Providing effective web reinforcement to resist diagonal tension in rectangular and T-beam sections is most essential. The intensity of the shearing stress for any point between the steel and the neutral axis is given by the formula—

$$v = \frac{V}{bjd}$$ for rectangular beams, and $$v = \frac{V}{b'jd}$$ for T-beams.

Since the value of j varies but slightly for the various percentages of steel, the ratio of $\frac{7}{8}$ may be substituted in above, in which case—

$$v = \frac{8V}{7\ bd}$$

If the unit shear v exceeds 40 lbs., then stirrups must be used, even with web reinforcement; v should never exceed 120 lbs. The combination of bent rods and stirrups gives the best result. It is good design to permit the stirrups to develop the required resistance to diagonal tension and allow the bent-up rods to act only as an additional safety factor. Stirrups placed at a distance apart greater than one-half the depth of the beam are of little value.

$v = \frac{V}{bjd}$ = total unit shearing stress

v_1 = unit shearing stress to be taken by concrete = 40 lbs.

V_1 = total shear to be taken by all stirrups in one of a beam.

X_1 = distance in feet from support to point beyond which stirrups are not required.

l = span of beam in feet.

A_s = sectional area of steel in one stirrup (2 legs for U-stirrup)

Then $V_1 = \frac{(v-v_1)\ bx_1}{2}$ (12)

$$X_1 = \frac{l}{2}\left(1 - \frac{v_1}{v}\right)$$

$\frac{V_1}{Af_s}$ = total number of stirrups for V_1

Stirrup spacing at the critical point near the bearing, assuming a given size of stirrup, will be—

$$\frac{Af_s}{(v-v_1)b}$$

With the distance x_1, total number of stirrups required and minimum spacing known, it will be safe to increase gradually the spacing over the distance x_1 from the smallest spacing to the maximum of d/2. The number of stirrups necessary in most cases can readily be determined from the table given on page 179. For intermediate values of v, the number required can be found by interpolation. For values of v between 40 and 80, it would be well to use not less than the minimum given.

Bond.—Adequate bond strength should be provided. The formula given for bond stresses in beams is for straight longitudinal bars. In restrained and cantilever beams, full tensile strength exists in the reinforcing bars at the point of support and the bars should be anchored in the support sufficiently to develop this stress. Adequate bond strength throughout the length of a bar is preferable to end anchorage, but, as an additional safeguard in special cases, the ends may be hooked.

Columns.—It is recommended that the ratio of unsupported length to least width be limited to 120. The reinforcement usually consists of longitudinal bars tied together by hoops at intervals of about 1/3 further or of longitudinal bars surrounded by spiral hooping. The amount of vertical reinforcing varies from about 1% to 8% of the core area, and of spiral hooping from 1/2% to 2% of the volume of the core. The cost is that portion of the compression of the concrete assumed to carry the load. The outside 1½ or 2 inches of the concrete is not considered in calculating the strength. If ordinary ties are economically loaded, bending stresses are induced, and the eccentricities should be investigated until the maximum stress is found. Formula (3) gives the total safe load for columns. Vertical bars in columns are usually spaced at four points by bending a sufficient distance to develop their stress in bond. Formulæ here are subject to the limits of formula (4).

Footings.—Reinforced concrete column footings are of several types. In addition to rectangular footings, the combined or mat footings, supporting two or more columns, or spread footings supported on piles, or rock, or hard footings, covering the entire foundation area. Reinforced concrete footings require much less depth than footings of masonry or plain concrete, but a sufficient amount of both concrete and steel must be used. The purpose of a footing is to receive and distribute the load uniformly over the soil. This is accomplished in the case of the single column by placing it at the center of the footing area. Where there are two columns close together, the center of gravity of the foundation area must coincide with the center of gravity of the column loads in order to secure uniformity of soil pressure. Having determined this point, the proportioning of the various portions proceeds in accordance with the principles of design for slabs and beams.

SOLID CONCRETE SLABS

1-2-4 Mix

SAFE LOADS IN POUNDS PER SQUARE FOOT

Including Weight of Slab

Continuous Spans. Unit Stress Steel = 16,000 lbs. per sq. in., Medium Steel.

Extreme Fiber Stress Concrete = 650 lbs. per sq. in.

n = 15

Thickness of Slab	Round Bars	Spacing	$M\ (in.\text{-}lb.) = \frac{wl^2}{12} \times 12$ Span in Feet															Weight of Slab (per square ft. lbs. Allowance Live Load)
			4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
5	½	3½	323	206	143	106	80											382
5½	½	5½	504	323	224	165	126	101	80									442½
6	½	8½	726	464	323	237	181	143	116	96	80							503
6½	½	7⅛	988	632	439	323	247	195	158	130	110	93						573½
7	½	10		826	573	421	323	255	206	170	143	122	106					634
7½	½	8⅞		1045	726	533	408	323	261	216	181	155	133	116	102			694½
8	½	5			896	658	504	397	323	266	224	191	165	143	126	111		755
8½	½	7½		1084	796	610	482	386	323	271	231	199	174	152	135	120		825½
9	½	10½			948	720	573	464	384	323	275	237	206	181	161	143		886
9½	½	8			1112	852	673	545	450	378	323	278	242	213	188	168		946½
10	½	5½				988	781	632	523	439	374	323	281	247	219	195	175	1067
10½	½	7½				1133	896	729	603	504	429	370	323	283	251	224	201	1127½
11	½	5					1010	826	682	573	488	421	367	323	286	255	229	1188
11½	½	6½					1151	932	770	647	551	476	414	364	323	287	258	1198½
12	½	8½						1045	863	726	618	533	464	408	363	323	289	1259

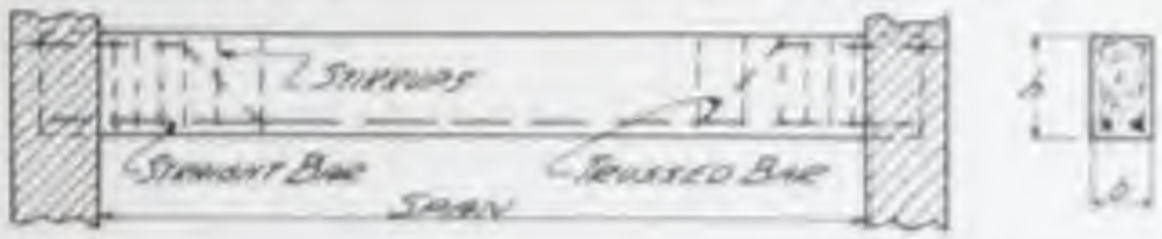
NOTE—This table is based on $M = \frac{wl^2}{12}$. Top reinforcement for negative M same area A_s as for positive M at center of span. Top steel over supports extended 1/5 to 1/4 of span. For end spans, when $M = \frac{wl^2}{10}$ use 5/6 of the values given above; for simple spans, when $M = \frac{wl^2}{8}$ use 2/3 of the above values.

To compute safe superimposed loads for spans, subtract corresponding weight of slab from the above values.

RECTANGULAR BEAMS

SIMPLE SPANS

Bending Moment: $M = \frac{1}{8}wl^2$ Unit Stresses: $f_s = 16{,}000$ $f_c = 650$



SIZE		Weight per Foot	ROUND BARS				SPAN OF BEAM IN FEET									
			Straight		Trussed											
d.	b.						10	12	14	16	18	20	21	22	23	24
In.	In.	Lbs.	No.	Size	No.	Size	Safe loads in Pounds per Foot Uniformly Distributed, Including Weight of Beam									
	6	75	1	⅝	1	½	459	318	234	179						
12	8	100	1	⅞	1	⅝	583	406	298	228						
	10	125	2	½	2	½	750	521	383	293	232					
	8	117	1	¾	1	⅝	849	590	433	331	262	212				
14	10	146	2	⅝	1	⅝	1048	729	535	410	324	262	238			
	12	175	2	⅝	2	⅝	1315	913	671	513	406	329	298			
	8	133	1	¾	1	¾	1140	799	587	450	355	288	261	238		
16	10	167	1	⅞	1	¾	1375	955	701	538	424	344	311	283		
	12	200	2	¾	1	¾	1724	1197	880	672	531	430	388	355		
	8	150	1	⅞	1	¾	1513	1050	771	591	467	378	343	312	285	
18	10	188	2	⅝	2	⅝	1855	1288	946	725	573	464	421	383	350	
	12	225	2	¾	1	⅞	2232	1550	1139	872	688	558	505	460	420	386
	14	262	2	¾	2	¾	2623	1825	1341	1027	812	657	596	542	496	456
	8	167	1	⅞	1	¾	1765	1225	901	690	545	442	400	364	333	306
20	10	208	2	¾	1	¾	2243	1560	1145	878	694	562	510	463	424	391
	12	250	2	⅞	2	¾	2878	1998	1468	1123	888	719	652	594	543	499
	14	292	2	⅞	2	⅞	3364	2337	1718	1315	1040	841	763	695	635	584
	8	183	1	⅞	1	⅞	2252	1563	1150	880	695	563	511	465	426	391
22	10	229	1	1	1	1	2885	2003	1472	1128	890	721	655	596	545	501
	12	275	2	¾	2	¾	3324	2310	1698	1300	1027	831	754	687	629	577
	14	321	2	⅞	2	¾	3012	2715	1995	1528	1207	977	886	808	739	679
	8	200	1	1	1	⅞	2800	1945	1430	1095	864	700	635	578	530	486
24	10	250	2	¾	2	¾	3551	2464	1812	1388	1097	887	805	734	671	616
	12	300	2	⅞	1	1	4080	2833	2082	1595	1260	1020	925	844	772	709
	14	350	2	⅞	2	⅞	4902	3405	2502	1915	1513	1227	1112	1013	926	851
	8	217	1	1	1	1	3373	2342	1720	1318	1040	843	765	697	638	585
26	10	271	2	⅞	1	1	4040	2810	2064	1580	1250	1011	918	836	765	702
	12	325	2	⅞	2	⅞	5114	3550	2610	1998	1580	1280	1160	1057	966	888
	14	379	2	1	2	⅞	5034	4118	3025	2317	1830	1482	1345	1225	1121	1030
	8	233	1	1	1	1	3807	2643	1944	1488	1176	952	864	787	720	661
28	10	292	2	⅞	1	1	4820	3350	2460	1884	1489	1205	1093	996	911	837
	12	350	2	⅞	2	⅞	5847	4060	2980	2283	1805	1461	1325	1208	1105	1015
	14	408	2	1	2	⅞	6722	4668	3430	2627	2077	1681	1525	1390	1271	1168
	10	312	2	1	1	1	5646	3918	2880	2301	1740	1410	1280	1167	1068	980
30	12	375	2	1	1	1	6705	4658	3425	2620	2070	1678	1521	1387	1268	1165
	14	437	2	1	2	1	7976	5540	4065	3115	2460	1993	1810	1648	1508	1385
	16	500	3	⅞	2	1	8825	6130	4500	3450	2725	2205	2000	1825	1670	1532

RECTANGULAR BEAMS

END SPANS

Bending Moment: $M = \frac{1}{10} w l^2$ Unit Stresses: $f_s = 16{,}000$ $f_c = 650$

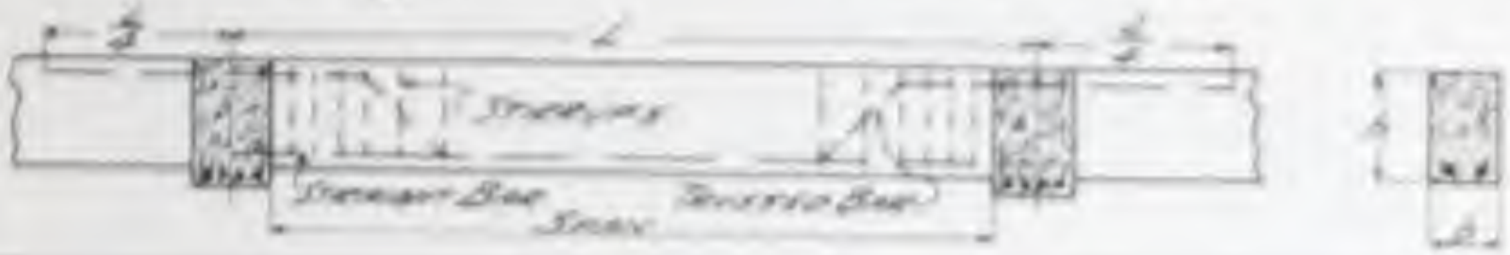
SIZE			BOND BARS				SPAN OF BEAM IN FEET									
		$\frac{d}{8}+\frac{3}{4}-\frac{1}{8}$	Straight		Trussed		10	12	14	16	18	20	21	22	23	24
b	h	$\frac{d}{8}-\frac{1}{8}$	No.	Size	No.	Size	Safe Loads in Pounds per Foot Uniformly Distributed, Including Weight of Beam									
	6	73	1	½	1	½	478	328	241	187						
12	8	101	1	⅝	1	⅝	729	500	372	284	225					
	10	125	2	½	2	½	967	651	478	366	289	234	212			
	8	147	1	⅝	1	⅝	880	614	449	344	272	220	200			
14	10	140	1	⅝	1	⅝	1250	868	638	488	386	312	283	257		
	12	175	2	½	2	½	1644	1143	838	642	507	411	373	339		
	8	133	1	⅝	1	⅝	1430	997	733	560	443	359	325	296	271	
16	10	167	1	⅞	1	⅞	1836	1275	936	716	566	458	416	378	346	
	12	200	2	⅝	2	⅝	2065	1412	1039	795	628	508	461	419	384	352
	8	159	1	⅝	1	⅝	1671	1163	853	653	516	418	379	345	315	290
18	10	188	2	⅞	2	⅝	2319	1610	1182	905	715	580	525	478	437	401
	12	225	2	1⅛	2	⅝	2540	1625	1193	914	722	585	530	482	441	405
	14	262	2	⅞	2	⅞	3279	2275	1672	1280	1011	820	744	677	620	569
	8	167	1	⅞	1	⅞	2401	1667	1225	937	741	600	544	495	454	416
20	10	208	2	⅞	2	⅞	2923	1821	1338	1024	810	656	594	541	495	454
	12	250	2	1¼	2	⅞	3597	2500	1835	1405	1111	899	816	742	679	624
	14	292	2	1¼	2	1¼	4752	3303	2426	1856	1468	1188	1078	981	898	825
	8	183	2	⅞	2	⅞	2888	2007	1474	1129	892	722	655	597	546	502
22	10	229	1	1	1	1	3606	2504	1843	1410	1112	901	818	745	682	626
	12	275	2	1¼	2	1¼	4135	2887	2121	1625	1283	1040	943	859	786	722
	14	321	2	1½	2	1½	5253	3650	2690	2062	1631	1322	1198	1091	999	918
	8	200	1	1⅛	1	1⅛	3316	2304	1693	1296	1024	829	752	685	627	576
24	10	250	2	1¼	2	1¼	4438	3088	2268	1737	1373	1111	1008	917	839	770
	12	300	2	1½	2	1½	4202	3187	2342	1793	1417	1148	1041	949	868	797
	14	350	2	1¾	2	1¾	6127	4257	3126	2395	1891	1531	1390	1267	1159	1063
	8	217	1	1	1	1	4216	2925	2150	1646	1300	1052	956	871	797	732
26	10	271	2	1¼	2	1¼	4976	3455	2540	1944	1536	1243	1129	1028	940	864
	12	325	2	1½	2	1½	6292	4440	3260	2495	1972	1598	1450	1325	1216	1118
	14	379	2	1¾	2	1¾	8263	5706	4190	3206	2535	2051	1864	1708	1569	1443
	8	233	1	1	1	1	4759	3305	2430	1860	1470	1190	1080	985	904	830
28	10	292	2	1¼	2	1¼	5429	3767	2769	2121	1674	1357	1230	1121	1029	942
	12	350	2	1½	2	1½	7308	5069	3730	2855	2257	1829	1656	1510	1382	1270
	14	467	2	1¾	2	1¾	9518	6610	4856	3720	2940	2384	2160	1969	1806	1652

Loads in "heavy" type should not be used unless stirrups are provided.

RECTANGULAR BEAMS

CONTINUOUS OVER SUPPORTS

Bending Moment: $M = \frac{1}{12} wl^2$ Unit Stresses: $f_s = 16{,}000$ $f_c = 650$



SIZE		Safe Shear in Pounds	ROUND BARS				SPAN OF BEAM IN FEET									
			Straight		Trussed											
h	b	$\frac{7}{8} \times$ Safe Unit Shear $\times bd$	No.	Size	No.	Size	10	12	14	16	18	20	21	22	23	24
In.	In.						Safe loads in Pounds per Foot Uniformly Distributed, Including Weight of Beam									
	6	75	1	½	1	½	568	394	290	222						
12	8	100	1	⅝	1	⅝	875	608	447	342	270	219				
	10	125	2	½	2	½	1125	781	574	440	347	281	255			
	8	117	1	⅝	1	⅝	1050	734	539	413	326	264	240			
14	10	146	1	¾	1	¾	1500	1040	765	585	463	375	340	309		
	12	175	2	⅝	2	⅝	1973	1371	1008	771	610	493	448	407		
	8	133	1	¾	1	¾	1724	1195	880	674	532	431	391	356	325	
16	10	167	1	⅞	1	⅞	2203	1530	1125	861	680	551	500	455	416	
	12	200	2	¾	2	¾	2442	1697	1247	955	754	610	554	504	461	423
	8	150	1	⅞	1	⅞	2005	1391	1022	783	619	501	455	414	378	347
18	10	188	2	⅝	2	⅝	2783	1932	1420	1088	859	696	631	575	526	483
	12	225	2	⅞	2	⅞	2808	1950	1433	1098	866	702	637	580	530	487
	14	262	2	1	2	1	3935	2732	2007	1537	1215	984	892	812	743	682
	8	167	1	⅞	1	⅞	2881	2003	1472	1127	890	721	654	595	545	501
20	10	208	2	⅞	2	⅞	3146	2184	1605	1229	972	786	713	649	594	545
	12	250	2	1	2	1	4317	3000	2205	1689	1335	1080	980	892	816	750
	14	292	2	1	2	1	4566	3139	2308	1761	1391	1127	1022	931	851	782
	8	183	2	⅞	2	⅞	**3466**	2407	1770	1355	1070	866	786	716	655	602
22	10	229	1	1	1	1	**4328**	3005	2208	1690	1336	1082	981	894	818	751
	12	275	2	1	2	1	4986	3460	2542	1946	1538	1246	1130	1030	942	865
	14	321	2	1	2	1	**6277**	4357	3203	2453	1939	1571	1423	1297	1188	1090
	8	200	1	1	1	1	**3730**	2591	1903	1457	1151	933	845	770	705	648
24	10	250	2	1	2	1	**5326**	3700	2730	2080	1644	1331	1208	1100	1008	923
	12	300	2	1	2	1	5510	3827	2812	2153	1700	1378	1250	1139	1042	958
	14	350	2	1	2	1	**7353**	5105	3750	2873	2269	1840	1668	1520	1390	1278
	8	217	1	1	1	1	**5060**	**3517**	2582	1978	1562	1265	1149	1047	956	879
26	10	271	2	1	2	1	**5972**	4150	3047	2333	1842	1493	1355	1235	1128	1038
	12	325	2	1	2	1	**7671**	**5327**	3911	2998	2367	1918	1740	1586	1450	1332
	14	379	2	1	2	1	**8114**	5640	4143	3170	2505	2030	1841	1679	1535	1410
	8	233	1	1	1	1	**5711**	**3965**	2915	2232	1764	1429	1296	1181	1080	993
28	10	292	2	1	2	1	**6504**	4518	3329	2540	2011	1627	1479	1344	1230	1130
	12	350	2	1	2	1	**8770**	**6095**	4475	3423	2711	2192	1990	1813	1659	1524
	16	467	2	1	2	1	**11422**	**7940**	5827	4460	3525	2856	2593	2362	2161	1983

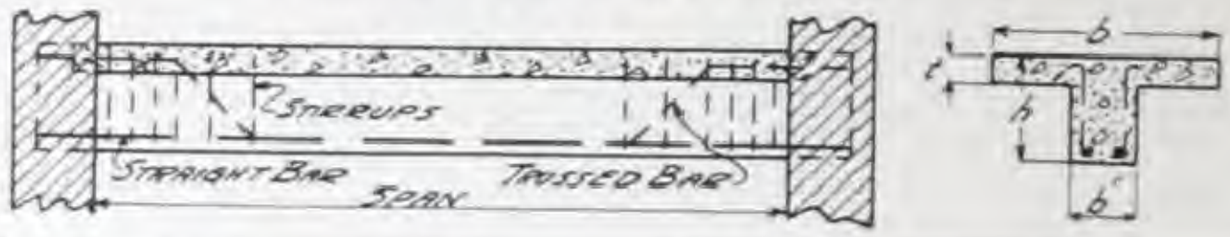
Loads in "**heavy**" type should not be used unless moments are provided.

TEE BEAMS

SIMPLE SPANS

Bending Moment: $M = \frac{1}{8} wl^2$ Unit Stresses: $f_s = 16.000$ $f_c = 650$

Minimum Value of t = 4 Inches



SIZE			Wt., Section lbs. per Foot	ROUND BARS				SPAN OF BEAM IN FEET									
				Straight		Trussed		10	12	14	16	18	20	22	24	25	26
h	b'	b		No.	Size	No.	Size	Safe Loads in Pounds per Foot Uniformly Distributed, Including Weight of Beam									
In.	In.	In.															
	6	18	75	1	1	1	7/8	1295	900	660	506						
12	8	23	100	1	1 1/8	1	1	1664	1156	849	650						
	10	31	125	2	1	1	1	**2195**	1525	1120	856						
	8	24	117	1	1 1/4	1	1 1/8	**2463**	1711	1257	963	761	616				
14	10	28	146	2	1	1	1 1/8	**2875**	1995	1467	1122	886	718				
	12	36	175	2	1 1/8	1	1 1/4	**3580**	2485	1828	1398	1105	895				
	8	25	133	2	7/8	2	7/8	**2954**	**2052**	1508	1153	912	738				
16	10	32	167	2	1	2	1	**3794**	**2635**	1936	1482	1171	948				
	12	36	200	3	1	2	7/8	**4430**	**3077**	2260	1731	1368	1108				
	8	26	150	2	1	2	7/8		**2717**	**1997**	1530	1208	978	808	679		
18	10	33	188	2	1 1/8	2	1		**3453**	**2538**	1943	1535	1244	1028	864		
	12	40	225	3	1	2	1 1/8		**4219**	**3097**	2372	1874	1519	1254	1054		
	8	27	167	2	1	2	1		**3458**	**2541**	**1945**	1537	1245	1028	864	797	737
20	10	34	208	3	1	2	1		**4380**	**3220**	**2463**	1947	1577	1302	1094	1008	932
	12	41	250	3	1	3	1		**5187**	**3811**	**2918**	2305	1867	1543	1297	1195	1105

								SPAN OF BEAM IN FEET									
								20	22	24	26	28	30	32	34	36	38
	8	29	183	2	2 1/8	2	1	1580	1305	1097	934	806	702				
22	10	36	229	3	1	2	1 1/8	1929	1594	1340	1140	984	857				
	12	44	275	3	1 1/8	3	1	2367	1957	1645	1400	1208	1052				
24	10	37	250	3	1	3	1	2308	1908	1602	1367	1178	1026	901			
	12	47	300	3	1 1/8	3	1 1/8	**2895**	2391	2009	1712	1475	1286	1130			
26	10	40	271	3	1 1/8	3	1	**2867**	**2369**	1991	1696	1463	1274	1119	992		
	12	47	325	3	1 1/4	2	1 1/4	**3293**	2721	2287	1948	1680	1462	1285	1140		
	10	44	292	3	1 1/8	3	1 1/8				2041	1758	1532	1347	1192	1064	954
28	12	49	350	3	1 1/4	3	1 1/8				2290	1975	1720	1512	1339	1195	1072
	14	59	408	4	1 1/8	4	1 1/8				2728	2352	2050	1800	1596	1424	1277
	10	44	312	3	1 1/4	2	1 1/4				**2287**	1970	1718	1509	1338	1193	1070
30	12	55	375	4	1 1/8	3	1 1/4				**2832**	2442	2127	1870	1657	1477	1326
	14	64	437	4	1 1/4	4	1 1/8				**3290**	2836	2470	2172	1923	1717	1540

Loads in "**heavy**" type should not be used unless stirrups are provided.

TEE BEAMS
END SPANS

Bending Moment $M = \frac{1}{10} wl^2$ Unit Stresses $f_s = 16{,}000$ $f_c = 650$

SIZE		$\frac{p}{100} = \frac{A_s}{bd}$	BEAM IN SLAB		DEPTH OF BEAM IN FEET							
b - In.	A_s - Sq. In.		Normal	Turned	10	12	14	16	18	20	22	24
In.	In.		No. and Size.	No. and Size.	Safe Load in Pounds per Foot, Uniformly Distributed, Including Weight of Beam							
12	6	.75	1-⅞	1-⅝	750	847	937	1023				
	8	1.00	1-1	1-⅞	1000	1097	1213	1324				
	10	1.25	1-1¼	1-1¼	1333	1422	1507	1589				
	12	1.50	2-⅞	2-⅝	1600	1722	1814	1897				
14	6	.86	1-1⅛	1-⅝	1200	1318	1412	1503	1591			
	8	1.14	1-1½	1-1¼	1600	1743	1857	1962	2063			
	10	1.43	1-1	1-1	1920	2132	2302	2447	2582			
	12	1.71	2-1¼	2-1⅛	2400	2579	2729	2866	2994			
16	8	1.00	1-1¼	1-1⅛	1800	1951	2074	2184	2286	2381		
	9	1.13	1-1	1-1	2172	2347	2500	2636	2762	2881		
	10	1.27	2-1¼	2-1⅛	2617	2807	2969	3113	3247	3373		
	12	1.50	1-1⅛ + 1-1	1-1 + 1-⅞	3000	3228	3412	3574	3723	3861		
18	8	1.00	1-1	1-1	2304	2511	2677	2815	2938	3048	3151	
	10	1.25	1-1⅛ + 1-1	1-1 + 1-⅛	3038	3344	3563	3743	3902	4047	4181	
	12	1.50	2-1⅛	2-1	4423	4717	4957	5159	5339	5504	5657	
	14	1.75	1-1 + 1-1¼	1-1 + 1-1⅛	5136	5527	5852	6131	6378	6602	6809	
20	8	1.00	1-1¼	1-1¼		2792	2980	3139	3276	3400	3513	
	10	1.25	2-1¼	2-1¼		3417	3654	3853	4026	4179	4317	
	12	1.50	1-1 + 1-1¼	1-1 + 1-1⅛		4033	4317	4553	4756	4936	5099	
	14	1.75	2-1	2-1		4640	4966	5239	5473	5679	5866	

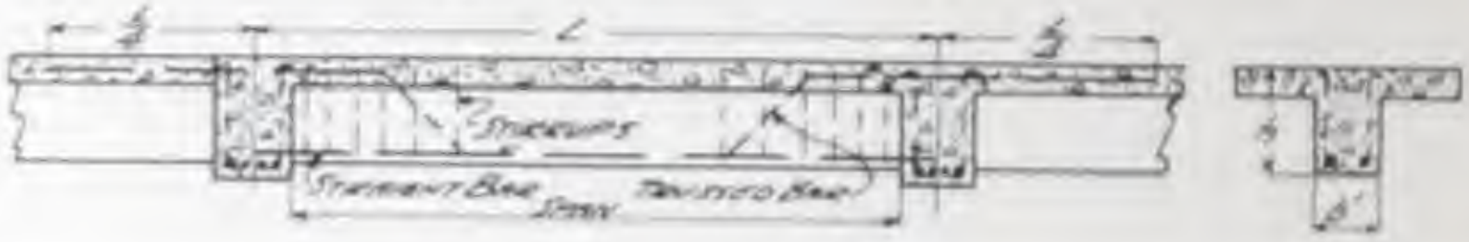
SIZE		$\frac{p}{100} = \frac{A_s}{bd}$	BEAM IN SLAB		DEPTH OF BEAM IN FEET							
b - In.	A_s - Sq. In.		Normal	Turned	16	18	20	22	24	26	28	30
In.	In.		No. and Size.	No. and Size.	Safe Load in Pounds per Foot, Uniformly Distributed, Including Weight of Beam							
22	8	.82	1-⅞	1-⅝	2451	2631	2788	2928	3054	3169	3274	
	10	1.02	1-1⅛	1-1	3189	3423	3628	3809	3974	4125	4262	
	12	1.23	2-⅞	2-⅝	3927	4215	4468	4690	4894	5081	5250	
	14	1.43	1-1 + 1-1⅛	1-1 + 1-1	4665	5007	5308	5572	5814	6037	6238	
	16	1.64	2-1⅛	2-1	5403	5799	6148	6454	6734	6992	7226	
	18	1.84	1-1 + 1-1¼	1-1 + 1-1⅛	6141	6591	6988	7336	7655	7948	8215	
24	8	.75	1-⅞	1-⅝	2798	3003	3183	3342	3486	3617	3737	
	10	.94	1-1⅛	1-1	3641	3908	4142	4348	4534	4702	4858	
	12	1.13	2-⅞	2-⅝	4483	4811	5100	5354	5583	5793	5986	
	14	1.31	1-1 + 1-1¼	1-1 + 1-1⅛	5326	5716	6059	6362	6635	6885	7114	
	16	1.50	2-1⅛	2-1	6169	6620	7018	7369	7685	7975	8241	
	18	1.69	1-1 + 1-1¼	1-1 + 1-1⅛	7011	7524	7977	8377	8737	9067	9370	
26	8	.69	1-⅞	1-⅝	3114	3342	3543	3721	3881	4027	4161	
	10	.87	1-1⅛	1-1	4053	4350	4611	4842	5049	5236	5408	
	12	1.04	2-⅞	2-⅝	4989	5354	5677	5962	6216	6447	6661	
	14	1.21	1-1 + 1-1¼	1-1 + 1-1⅛	5929	6363	6746	7084	7386	7660	7914	
	16	1.39	2-1⅛	2-1	6866	7369	7812	8204	8554	8873	9167	
	18	1.56	1-1 + 1-1¼	1-1 + 1-1⅛	7803	8374	8878	9324	9723	10085	10419	
28	8	.64	1-⅞	1-⅝	3430	3681	3903	4100	4276	4435	4581	
	10	.80	1-1⅛	1-1	4464	4791	5079	5334	5563	5770	5959	
	12	.96	2-⅞	2-⅝	5497	5898	6253	6568	6850	7104	7337	
	14	1.12	1-1 + 1-1¼	1-1 + 1-1⅛	6530	7006	7427	7801	8136	8438	8715	
	16	1.28	2-1⅛	2-1	7562	8114	8601	9034	9421	9771	10092	
	18	1.44	1-1 + 1-1¼	1-1 + 1-1⅛	8593	9221	9774	10267	10707	11104	11469	
30	8	.59	1-⅞	1-⅝	3746	4020	4262	4479	4672	4844	5004	
	10	.74	1-1⅛	1-1	4875	5232	5547	5828	6078	6302	6508	
	12	.89	2-⅞	2-⅝	6004	6443	6830	7176	7484	7760	8014	
	14	1.03	1-1 + 1-1¼	1-1 + 1-1⅛	7133	7653	8113	8523	8888	9215	9518	
	16	1.18	2-1⅛	2-1	8262	8864	9396	9870	10293	10670	11019	
	18	1.33	1-1 + 1-1¼	1-1 + 1-1⅛	9391	10076	10680	11217	11697	12126	12523	
32	8	.55	1-⅞	1-⅝	4062	4358	4621	4856	5066	5253	5426	
	10	.69	1-1⅛	1-1	5286	5672	6014	6319	6592	6836	7061	
	12	.83	2-⅞	2-⅝	6510	6985	7406	7782	8118	8418	8695	
	14	.96	1-1 + 1-1¼	1-1 + 1-1⅛	7734	8298	8798	9245	9645	10002	10331	
	16	1.10	2-1⅛	2-1	8958	9611	10190	10707	11170	11582	11963	
	18	1.24	1-1 + 1-1¼	1-1 + 1-1⅛	10182	10924	11582	12169	12695	13165	13596	
34	8	.52	1-⅞	1-⅝	4378	4696	4980	5233	5460	5663	5849	
	10	.65	1-1⅛	1-1	5698	6113	6482	6812	7107	7370	7612	
	12	.78	2-⅞	2-⅝	7018	7529	7983	8388	8750	9074	9373	
	14	.91	1-1 + 1-1¼	1-1 + 1-1⅛	8338	8945	9484	9965	10396	10781	11137	
	16	1.04	2-1⅛	2-1	9658	10362	10987	11544	12043	12488	12899	
	18	1.17	1-1 + 1-1¼	1-1 + 1-1⅛	10978	11778	12489	13123	13691	14198	14667	
36	8	.49	1-⅞	1-⅝	4694	5034	5339	5610	5853	6071	6270	
	10	.62	1-1⅛	1-1	6110	6554	6950	7303	7619	7902	8161	
	12	.74	2-⅞	2-⅝	7526	8073	8560	8995	9385	9733	10052	
	14	.86	1-1 + 1-1¼	1-1 + 1-1⅛	8942	9593	10172	10689	11152	11566	11945	
	16	.99	2-1⅛	2-1	10358	11112	11784	12384	12922	13403	13843	
	18	1.11	1-1 + 1-1¼	1-1 + 1-1⅛	11774	12631	13396	14080	14693	15241	15742	

Loads in "Safety" type should not be used unless stresses are corrected

TEE BEAMS

CONTINUOUS OVER SUPPORTS

Bending Moment: $M = \frac{1}{12} w l^2$ Unit Stresses: $f_s = 16{,}000$ $f_c = 650$



SIZE			ROUND BARS		SPAN OF BEAM IN FEET							
b,	h,	Wt. Stirrups & Tie Bars per Foot	Straight	Trussed	10	12	14	16	18	20	22	24
In.	In.		No. and Size	No. and Size	Safe Loads in Pounds per Foot, Uniformly Distributed, Including Weight of Beam							
	6	75	1-$\frac{3}{4}$	1-$\frac{5}{8}$	840	584	429	328				
12	8	100	1-$\frac{7}{8}$	1-$\frac{3}{4}$	1203	836	614	470				
	10	125	1-1$\frac{1}{8}$	1-$\frac{7}{8}$	1612	1120	824	630				
	12	150	2-$\frac{3}{4}$	2-$\frac{5}{8}$	1680	1167	857	656				
	6	88	1-$\frac{3}{4}$	1-$\frac{3}{4}$	1442	1001	735	564	445			
14	8	117	1-1$\frac{1}{8}$	1-$\frac{7}{8}$	1944	1350	992	759	600			
	10	146	1-1	1-1	2473	1719	1262	966	764			
	12	175	2-1$\frac{1}{4}$	2-1$\frac{1}{4}$	2884	2004	1472	1127	890			
	6	100	1-1$\frac{1}{8}$	1-1$\frac{1}{8}$	**2161**	**1501**	1102	844	667	540		
16	8	133	1-1	1-1	**2846**	**1976**	1452	1111	878	712		
	10	167	2-1$\frac{1}{4}$	2-1$\frac{1}{4}$	**3381**	2348	1725	1321	1044	845		
	12	200	1-1$\frac{1}{8}$ + 1-$\frac{3}{4}$	1-1$\frac{1}{8}$ + 1-$\frac{3}{4}$	**4027**	2796	2054	1573	1243	1006		
	8	150	1-1	1-1		2412	1772	1357	1072	868	718	603
18	10	188	1-1$\frac{1}{8}$ + 1-$\frac{3}{4}$	1-1$\frac{1}{8}$ + 1-$\frac{3}{4}$		3173	2331	1787	1411	1142	944	793
	12	225	2-1$\frac{1}{8}$	2-1$\frac{1}{8}$		3686	2708	2074	1638	1327	1097	922
	14	262	1-1 + 1-$\frac{3}{4}$	1-1 + 1-$\frac{3}{4}$		4285	3147	2410	1904	1542	1275	1071
	8	167	1-1$\frac{1}{8}$	1-1$\frac{1}{8}$			**2460**	1883	1490	1206	996	837
20	10	208	2-1$\frac{1}{8}$	2-1$\frac{1}{8}$			3012	2308	1822	1476	1220	1025
	12	250	1-1 + 1-1$\frac{1}{8}$	1-1 + 1-1$\frac{1}{8}$			**3555**	2725	2152	1742	1440	1210
	14	292	2-1	2-1			**4025**	3080	2435	1972	1630	1370

SIZE			SPAN OF BEAM IN FEET							
b,	h,	Wt. Stirrups & Tie Bars per Foot	16	18	20	22	24	26	28	30
In.	In.		Safe Loads in Pounds per Foot, Uniformly Distributed, Including Weight of Beam							
	8	183	1-1$\frac{1}{8}$	1-1$\frac{1}{8}$	**2172**	1716	1390	1140	965	823	709	
22	10	229	1-1 + 1-$\frac{3}{4}$	1-1 + 1-$\frac{3}{4}$	**2937**	2320	1879	1552	1305	1111	960	
	12	275	2-1	2-1	**3450**	2725	2206	1824	1533	1306	1127	
	14	321	3-1$\frac{1}{8}$	3-1$\frac{1}{8}$	**3955**	3125	2531	2092	1758	1498	1291	
	10	250	1-1 + 1-$\frac{3}{4}$	1-1 + 1-$\frac{3}{4}$		**2652**	2147	1775	1492	1271	1096	955
24	12	300	3-$\frac{7}{8}$	3-$\frac{7}{8}$		**3375**	2733	2259	1898	1617	1395	1215
	14	350	2-1$\frac{1}{8}$	2-1$\frac{1}{8}$		**3800**	3078	2544	2137	1821	1570	1368
	16	400	3-1	3-1		**4455**	3610	2980	2505	2134	1840	1603
	10	271	2-1	2-1			**2660**	2198	1849	1574	1358	1182
26	12	325	2-1$\frac{1}{8}$	2-1$\frac{1}{8}$			**3290**	2718	2285	1945	1678	1461
	14	375	1-1$\frac{1}{8}$ + 1-1$\frac{1}{8}$	1-1$\frac{1}{8}$ + 1-1$\frac{1}{8}$			**3740**	3090	2595	2211	1907	1661
	16	433	2-1 + 2-$\frac{7}{8}$	2-1 + 2-$\frac{7}{8}$			**4493**	**3713**	3121	2658	2292	1997

Loads in "**heavy**" type should not be used unless stirrups are provided.

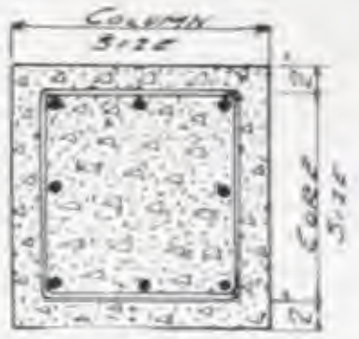
STIRRUP REINFORCEMENT
FOR UNIFORMLY LOADED BEAMS

Unit Stresses,
$f_s = 16{,}000$
$v = 40$

NOTE.—The table gives total number of stirrups per beam. Place one-half the number at each end of beam, as shown.

Clear Span of Beam,	Number and Size of Round Bar U-Stirrups							
	End Shear = **80 Lbs.** per Sq. In.				End Shear = **100 Lbs.** per Sq. In.			
	Width of Beam, In.				Width of Beam, In.			
Feet	8	10	12	14	8	10	12	14
10	6 3/4	8 1/2	10 3/4	10 3/4	12 1/4	6 3/4	8 1/2	10 3/4
12	8 1/2	10 3/4	12 1/4	12 1/4	6 3/4	8 1/2	10 3/4	10 3/4
14	10 3/4	12 1/4	14 1/4	16 1/4	8 1/2	10 3/4	10 3/4	12 1/4
16	10 3/4	12 1/4	8 1/2	8 1/2	8 1/2	10 3/4	12 1/4	14 1/4
18	12 1/4	14 1/4	8 1/2	8 1/2	10 3/4	12 1/4	14 1/4	16 1/4
20	12 1/4	16 1/4	8 1/2	10 3/4	10 3/4	12 1/4	16 1/4	18 1/4
22	14 1/4	18 1/4	10 3/4	10 3/4	12 1/4	14 1/4	16 1/4	20 1/4
24	16 1/4	18 1/4	10 3/4	12 1/4	12 1/4	16 1/4	18 1/4	22 1/4
26	16 1/4	20 1/4	12 1/4	12 1/4	14 1/4	16 1/4	20 1/4	22 1/4
28	18 1/4	22 1/4	12 1/4	14 1/4	14 1/4	18 1/4	20 1/4	24 1/4
30	18 1/4	24 1/4	12 1/4	14 1/4	16 1/4	18 1/4	22 1/4	26 1/4

Clear Span of Beam,	Number and Size of Round Bar U-Stirrups							
	End Shear = **120 Lbs.** per Sq. In.				End Shear = **140 Lbs.** per Sq. In.			
	Width of Beam, In.				Width of Beam, In.			
Feet	8	10	12	14	8	10	12	14
10	8 1/4	10 1/2	12 1/4	14 1/4	10 1/4	12 1/4	14 1/4	10 1/2
12	10 1/4	12 1/4	14 1/4	16 1/4	12 1/4	14 1/4	10 1/2	12 1/2
14	10 1/4	14 1/4	16 1/4	18 1/4	14 1/4	18 1/4	12 1/2	14 1/2
16	12 1/4	14 1/4	18 1/4	12 1/2	16 1/4	20 1/4	14 1/2	16 1/2
18	14 1/4	16 1/4	20 1/4	14 1/2	18 1/4	22 1/4	16 1/2	18 1/2
20	16 1/4	18 1/4	22 1/4	16 1/2	20 1/4	24 1/4	16 1/2	20 1/2
22	16 1/4	20 1/4	24 1/4	16 1/2	22 1/4	26 1/4	14 1/2	22 1/2
24	18 1/4	22 1/4	26 1/4	18 1/2	24 1/4	30 1/4	20 1/2	24 1/2
26	20 1/4	24 1/4	28 1/4	20 1/2	26 1/4	18 1/2	22 1/2	26 1/2
28	20 1/4	26 1/4	30 1/4	20 1/2	28 1/4	20 1/2	24 1/2	28 1/2
30	22 1/4	28 1/4	32 1/4	22 1/2	30 1/4	20 1/2	26 1/4	30 1/2

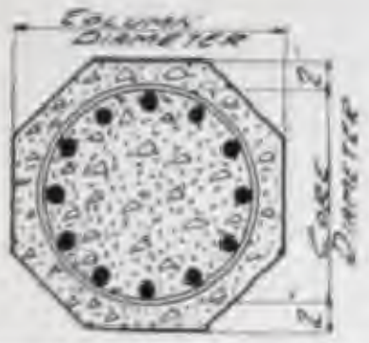


SQUARE TIED COLUMNS

SAFE AXIAL LOADS IN THOUSANDS OF POUNDS

Ratio of Length of Column to its Side, Limited to 15

Column Size, In.	Core Size, In.	Round Bar Ties		Round Bar Verticals		1: 2: 4 Concrete fc = 500 lbs. per sq. in. n = 15	1: 1½: 3 Concrete fc = 600 lbs. per sq. in. n = 12
		Size, In.	Spacing In.	No.	Size		
12	8	¼	7	4	½	38	44
		¼	9	4	⅝	41	46
		¼	11	4	¾	44	50
		¼	12	4	⅞	49	54
14	10	¼	9	4	⅝	59	68
		¼	11	4	¾	62	72
		¼	12	4	⅞	67	76
		¼	12	4	1	72	81
		¼	12	4	1⅛	78	86
16	12	¼	11	4	¾	84	98
		¼	12	4	⅞	89	102
		¼	12	4	1	94	107
		¼	12	4	1⅛	100	113
		¼	12	6	1⅛	114	126
18	14	¼	12	4	1	120	139
		¼	12	6	⅞	123	142
		¼	12	6	1⅛	140	158
		¼	12	8	1⅛	154	171
20	16	¼	12	6	⅞	153	177
		¼	12	8	⅞	162	185
		¼	12	8	1⅛	184	206
		¼	12	10	1⅛	197	219
22	18	¼	12	6	1	195	226
		¼	12	8	1	206	236
		¼	12	8	1¼	231	259
		¼	12	12	1⅛	245	273
24	20	¼	12	6	1⅛	242	279
		¼	12	10	1	255	292
		¼	12	12	1⅛	284	319
		¼	12	16	1⅛	311	345
26	22	¼	12	10	1	297	342
		¼	12	12	1	308	353
		¼	12	14	1⅛	340	382
		¼	12	18	1⅛	367	409
28	24	¼	12	12	1	354	408
		¼	12	14	1	365	418
		¼	12	18	1⅛	413	463
		¼	12	22	1⅛	441	490
30	26	¼	12	12	1	404	468
		¼	12	14	1⅛	435	497
		¼	12	20	1⅛	477	537
		¼	12	22	1¾	527	584



SPIRAL COLUMNS

SAFE AXIAL LOADS IN THOUSANDS OF POUNDS

Ratio of Length of Column to its Side or Diameter, Limited to 15.

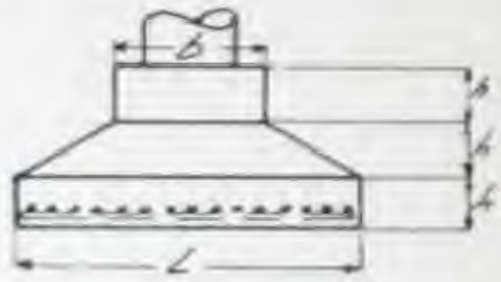
Column Diam., In.	Core Diam., In.	Round Bar Verticals No.	Round Bar Verticals Size	1 : 2 : 4 Concrete $f_c = 500$ lbs. per sq. in. $n = 15$		1 : 1½ : 3 Concrete $f_c = 600$ lbs. per sq. in. $n = 12$	
16	12	4	¾	¼"dia.-2"pitch 104	⅜"dia.-1 7/8"pitch 128	¼"dia.-2"pitch 115	⅜"dia.-1 7/8"pitch 139
		4	⅞	109	133	119	143
		4	1	114	138	124	148
		7	⅞	122	146	131	155
18	14	5	¾	¼"dia.-1¾"pitch 139	⅜"dia.-2¼"pitch 173	¼"dia.-1¾"pitch 154	⅜"dia.-2¼"pitch 188
		5	⅞	145	179	159	193
		6	1	157	191	170	204
		8	1	168	202	181	214
20	16	7	¾	⅜"dia.-2½"pitch 182	⅜"dia.-1 7/8"pitch 233	⅜"dia.-2½"pitch 200	⅜" dia.-1 7/8"pitch 252
		7	⅞	189	241	208	259
		8	1	204	255	222	273
		10	1	215	266	232	283
22	18	9	¾	⅜"dia.-2¼"pitch 229	7/16"dia.-2⅜"pitch 294	⅜"dia.-2¼"pitch 253	7/16"dia.-2⅜"pitch 317
		9	⅞	239	304	263	327
		10	1	256	321	279	343
		12	1	267	332	289	353
24	20	10	¾	⅜"dia.-2"pitch 281	7/16"dia.-2¼"pitch 350	⅜"dia.-2"pitch 311	7/16"dia.-2¼"pitch 380
		10	⅞	292	361	321	390
		12	1	316	385	344	413
		12	1⅛	333	403	360	429
26	22	9	¾	⅜"dia.-2½"pitch 332	½"dia.-2"pitch 419	⅜"dia.-2½"pitch 368	½"dia.-2"pitch 455
		10	⅞	346	433	382	468
		10	1	359	446	394	481
		13	1⅛	395	481	427	514
		15	1¼	408	495	441	527
28	24	10	¾	⅜"dia.-2¼"pitch 395	½"dia.-2⅜"pitch 496	⅜"dia.-2¼"pitch 438	½"dia.-2⅜"pitch 540
		10	1	419	520	461	562
		12	1	430	531	471	572
		14	1⅛	461	563	501	602
		15	1¼	493	594	531	632
30	26	10	⅞	⅜"dia.-2½"pitch 467	½"dia.-2¼"pitch 581	⅜"dia.-2½"pitch 518	½"dia.-2¼"pitch 632
		10	1	480	594	530	644
		12	1⅛	508	623	556	671
		16	1¼	536	651	583	697
		17	1¾	571	685	615	730

NOTE.—Size and pitch of spiral wire given at head of group of loads for each size column.

SQUARE COLUMN FOOTINGS

Unit Stresses:

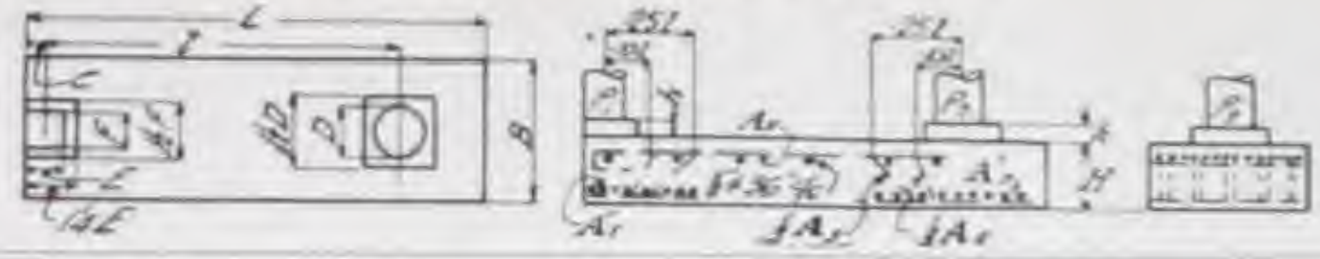
$f_s = 16{,}000$ $f_c = 650$



L		Soil Value Lbs per Sq. Ft.	Column Load in 1000 Lbs	Minimum Column Diam., In.	h		b		Reinforcement Round Bars Each Way		Weight of Steel, Lbs.	Volume of Concrete Cu. Ft.
Ft.	In.				Ft.	In.	Ft.	In.	No.	Size		
5	0	4000	96	13	0	7	1	10	14	½	88.8	23.7
5	0	6000	145	16	0	8	2	3	16	½	100.3	29.3
5	6	4000	116	14	0	8	2	1	14	½	97.0	33.3
5	6	6000	175	17	0	10	2	6	15	½	104.0	44.3
6	0	4000	137	15	0	9	2	3	14	½	106.3	44.5
6	0	6000	207	18	0	11	2	9	16	½	121.4	58.2
6	6	4000	161	16	0	9	2	4	17	½	140.3	51.6
6	6	6000	242	19	1	0	2	10	17	½	140.3	73.2
7	0	4000	186	17	0	10	2	6	17	½	151.5	66.2
7	0	6000	280	20	1	1	3	1	18	½	160.4	92.3
7	6	4000	212	18	0	11	2	9	18	½	172.3	84.3
7	6	6000	322	22	1	1	3	3	20	½	191.4	105.2
8	0	4000	240	19	1	0	2	10	18	½	184.1	103.6
8	0	6000	363	22	1	3	3	6	20	½	204.6	138.7
8	6	4000	272	20	1	0	2	11	21	½	228.7	116.0
8	6	6000	410	24	1	3	3	8	23	½	250.5	155.8
9	0	4000	303	21	1	1	3	2	21	½	242.6	141.8
9	0	6000	456	24	1	5	3	11	22	½	254.1	198.5
9	6	4000	333	21	1	3	3	5	16	⅝	310.8	183.4
9	6	6000	506	25	1	6	4	1	18	⅝	349.7	233.2
10	0	4000	370	22	1	3	3	6	17	⅝	384.1	201.7
10	0	6000	559	26	1	7	4	3	19	⅝	389.0	271.6
10	6	4000	405	23	1	4	3	8	18	⅝	387.5	237.0
10	6	6000	614	28	1	8	4	7	19	⅝	409.0	318.5
11	0	4000	442	24	1	5	3	11	18	⅝	406.4	277.8
11	0	6000	671	28	1	9	4	8	20	⅝	451.5	363.0
11	6	4000	484	25	1	5	4	0	20	⅝	472.5	301.8
11	6	6000	731	30	1	10	4	1	21	⅝	496.1	416.8
12	0	4000	524	26	1	6	4	2	22	⅝	542.9	347.8
12	0	6000	792	31	1	11	5	2	22	⅝	542.9	475.9
12	6	4000	566	26	1	7	4	3	23	⅝	591.7	396.0
12	6	6000	857	32	2	0	5	4	22	⅞	766.0	537.0

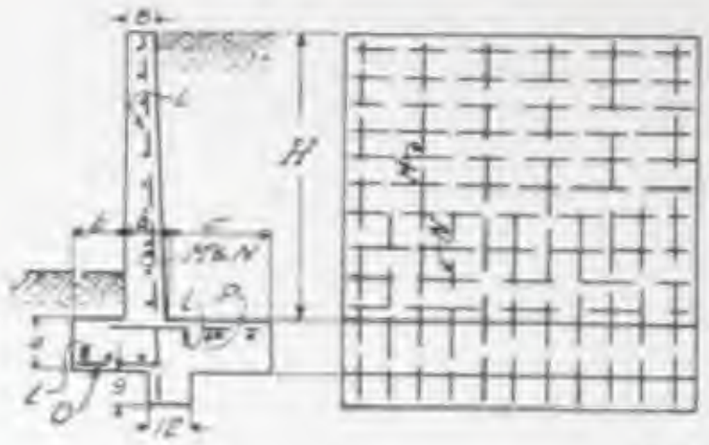
COMBINED COLUMN FOOTINGS

A_s = Tension steel in top
A'_s = Transverse steel under column P_2
A''_s = Transverse steel under column P_1
l = Distance c. to c. of columns in feet



Unit Stresses:
$f_s = 16{,}000$
$f_c = 650$

P_1+P_2, Lbs.	$\frac{P_1}{P_2}$	$\frac{L}{Ft.}$	Soil Value = 4,000 lbs. per square foot						Soil Value = 5,000 pounds per square foot					
			B, Ft.	H, Ft.	h, Ft.	As Sq. In.	A's Sq. In.	A''s Sq. In.	B, Ft.	H, Ft.	h, Ft.	As, Sq. In.	A's Sq. In.	A''s, Sq. In.
300,000	1.2	1.09l +2c	71/l	0.17l +0.25	l	12.9	638/l^2	532/l^2	58/l	0.19l +0.25	l	11.6	456/l^2	380/l^2
	1.3	1.13l +2c	71/l	0.17l +0.25	2.3- —	12.4	630/l^2	485/l^2	56/l	0.19l +0.25	2.1- —	11.1	455/l^2	350/l^2
	1.4	1.17l +2c	69/l	0.16l +0.25	6	12.4	680/l^2	480/l^2	54/l	0.18l +0.25	6	11.0	476/l^2	340/l^2
	1.5	1.20l +2c	67/l	0.16l +0.25		11.7	670/l^2	450/l^2	53/l	0.18l +0.25		10.4	482/l^2	322/l^2
400,000	1.2	1.09l +2c	98/l	0.17l +0.25		17.4	1121/l^2	935/l^2	77/l	0.19l +0.25		15.6	805/l^2	671/l^2
	1.3	1.13l +2c	96/l	0.17l +0.25	l	16.2	1142/l^2	895/l^2	75/l	0.19l +0.25	l	14.5	817/l^2	628/l^2
	1.4	1.17l +2c	93/l	0.16l +0.25	2.8- —	16.2	1225/l^2	875/l^2	73/l	0.18l +0.25	2.6- —	14.5	871/l^2	622/l^2
	1.5	1.20l +2c	90/l	0.16l +0.25	6	15.5	1200/l^2	810/l^2	71/l	0.18l +0.25	6	13.8	867/l^2	578/l^2
500,000	1.2	1.09l +2c	122/l	0.17l +0.25		21.4	1734/l^2	1446/l^2	96/l	0.19l +0.25		19.2	1249/l^2	1041/l^2
	1.3	1.13l +2c	119/l	0.17l +0.25	l	20.0	1710/l^2	1420/l^2	94/l	0.19l +0.25	l	17.9	1283/l^2	987/l^2
	1.4	1.17l +2c	115/l	0.16l +0.25	3.2- —	20.0	1870/l^2	1340/l^2	91/l	0.18l +0.25	3.0- —	17.9	1357/l^2	966/l^2
	1.5	1.20l +2c	111/l	0.16l +0.25	6	19.3	1840/l^2	1220/l^2	88/l	0.18l +0.25	6	17.2	1330/l^2	887/l^2
600,000	1.2	1.09l +2c	146/l	0.17l +0.25		25.8	2480/l^2	2070/l^2	115/l	0.19 +0.25		23.1	1794/l^2	1494/l^2
	1.3	1.13l +2c	141/l	0.17l +0.25	l	24.4	2397/l^2	2000/l^2	111/l	0.19 +0.25	l	21.9	1788/l^2	1375/l^2
	1.4	1.17l +2c	136/l	0.16l +0.25	3.6- —	24.4	2620/l^2	1870/l^2	107/l	0.18 +0.25	3.3- —	21.9	1867/l^2	1333/l^2
	1.5	1.20l +2c	133/l	0.16l +0.25	6	23.1	2630/l^2	1760/l^2	105/l	0.18 +0.25	6	20.6	1894/l^2	1263/l^2
700,000	1.2	1.09l +2c	169/l	0.17l +0.25		29.9	3330/l^2	2770/l^2	133/l	0.19l +0.25		26.8	2390/l^2	1996/l^2
	1.3	1.13l +2c	164/l	0.17l +0.25	l	27.9	3240/l^2	2705/l^2	129/l	0.19l +0.25	l	25.0	2420/l^2	1860/l^2
	1.4	1.17l +2c	159/l	0.16l +0.25	3.9- —	28.0	3580/l^2	2550/l^2	125/l	0.18l +0.25	3.6- —	24.9	2555/l^2	1820/l^2
	1.5	1.20l +2c	155/l	0.16l +0.25	6	26.4	3590/l^2	2380/l^2	122/l	0.18l +0.25	6	23.5	2555/l^2	1703/l^2



CANTILEVER RETAINING WALLS

Surface of Earth Horizontal

Angle of Repose, 33°
Weight of earth, 100 lbs. per cu. ft.
$f_s = 16{,}000$ lbs. per sq. in.
$f_c = 650$ lbs. per sq. in.
$n = 15$

CONCRETE

Height of Wall H, Feet	a	b	c	Soil Pressure at Toe, Lbs. per sq. ft.	Soil Pressure at Heel, Lbs. per sq. ft.	Concrete per ft. Length of Wall, Cubic Feet
7	1' 0"	1' 0"	1' 10"	1460	90	10 41
8	1' 1"	1' 1"	2' 1"	1470	270	12 35
9	1' 1"	1' 2"	2' 9"	1770	130	14 04
10	1' 2"	1' 4"	2' 10"	2000	60	16 14
11	1' 2"	1' 6"	3' 2"	2100	90	17 65
12	1' 3"	1' 8"	3' 7"	2210	160	20 37
13	1' 4"	1' 8"	4' 0"	2480	120	23 10
14	1' 4"	2' 1"	4' 3"	2400	240	24 95
15	1' 5"	2' 1"	4' 7"	2680	200	27 79
16	1' 5"	2' 2"	4' 11"	2870	170	29 45
17	1' 6"	2' 3"	5' 3"	3060	160	32 65
18	1' 7"	2' 4"	5' 7"	3280	140	36 00
19	1' 7"	2' 6"	6' 1"	3350	230	38 25
20	1' 8"	2' 8"	6' 6"	3430	310	42 13

REINFORCEMENT

Bars in all Cases of Round Section.

Height, Wall H in Feet	M Bars			N Bars			O Bars			P Bars			L Bars			Wt. per Ft. Length of Wall
	Size	Spacing in In.	Length	Size	Spacing in In.	Length	Size	Spacing in In.	Length	Size	Spacing in In.	Length	No.	Size	Spacing in In.	
7	⅝	24	8' 6"	½	24	3' 9"	⅝	12	2' 3"	⅝	12	3' 0"	12	½	12	14 4
8	⅝	24	9' 6"	½	24	4' 3"	⅝	12	2' 3"	⅝	12	3' 3"	13	½	12	15 7
9	⅝	17	10' 6"	½	17	4' 9"	⅝	12	2' 3"	⅝	11½	4' 3"	15	½	12	21 3
10	⅝	24	11' 9"	⅝	24	5' 10"	⅝	10	2' 6"	⅞	9½	4' 6"	16	½	12	26 2
11	⅝	16	12' 9"	⅝	16	5' 3"	⅝	7½	2' 9"	½	8	4' 9"	17	½	12	32 3
12	¾	20	14' 3"	¾	20	6' 3"	⅝	11	3' 3"	⅝	10	6' 6"	20	½	12	41 8
13	¾	16	15' 3"	¾	16	6' 6"	⅝	10½	3' 3"	⅝	12	6' 6"	22	⅝	12	63 4
14	¾	13	16' 3"	¾	13	6' 6"	⅝	11	4' 0"	¾	10	6' 9"	24	⅝	12	75 4
15	⅞	16	17' 6"	⅞	16	7' 3"	⅝	10	4' 0"	¾	13	7' 6"	26	⅝	12	88 9
16	⅞	13	18' 6"	⅞	13	7' 3"	⅝	9	4' 3"	¾	9½	7' 9"	27	⅝	12	105 2
17	1	15	19' 6"	1	15	8' 0"	⅝	8½	4' 3"	¾	8	8' 0"	29	⅝	12	122 2
18	1	13	20' 6"	1	13	8' 3"	⅝	7½	4' 3"	¾	7½	8' 6"	30	⅝	12	139 8
19	1¼	14	21' 6"	1¼	14	8' 9"	¾	9	3' 0"	1	7¼	9' 3"	33	⅝	12	174 7
20	1¼	13	22' 6"	1¼	13	9' 0"	¾	8½	3' 0"	1	7	9' 9"	34	⅝	12	192 9

Hooks are required at lower end of M and N Bars for walls over 11' 0" in height.

BIRMINGHAM WIRE GAUGE

EQUIVALENTS IN INCHES

CORRESPONDING WEIGHTS OF FLAT ROLLED STEEL

Gauge Number	Thickness, Inches	Pounds per Square Foot	Thickness, Inches		Pounds per Square Foot
			Fractional	Decimal	
			1/2	.5	20.4
0000	.454	18.5232	15/32	.46875	19.125
000	.425	17.34	7/16	.4375	17.85
			13/32	.40625	16.575
00	.380	15.504	3/8	.375	15.3
0	.340	13.872	11/32	.34375	14.025
1	.300	12.24	5/16	.3125	12.75
2	.284	11.5872	19/64	.296875	12.1125
3	.259	10.5672	9/32	.28125	11.475
			17/64	.265625	10.8375
4	.238	9.7104	1/4	.25	10.2
5	.220	8.976	15/64	.234375	9.5625
6	.203	8.2824	7/32	.21875	8.925
7	.180	7.344	13/64	.203125	8.2875
8	.165	6.732	3/16	.1875	7.65
9	.148	6.0384	11/64	.171875	7.0125
10	.134	5.4672	5/32	.15625	6.375
11	.120	4.896	9/64	.140625	5.7375
12	.109	4.4472	1/8	.125	5.1
13	.095	3.876	7/64	.109375	4.4625
14	.083	3.3864	3/32	.09375	3.825
15	.072	2.9376	5/64	.078125	3.1875
16	.065	2.652			
17	.058	2.3664	1/16	.0625	2.55
18	.049	1.9992			
19	.042	1.7136	3/64	.046875	1.9125
20	.035	1.428			
21	.032	1.3056			
22	.028	1.1424	1/32	.03125	1.275
23	.025	1.02			
24	.022	0.8976			
25	.020	0.816			
26	.018	0.7344			
27	.016	0.6528			
28	.014	0.5712	1/64	0.15625	0.6375
29	.013	0.5304			
30	.012	0.4896			
31	.010	0.408			
32	.009	0.3672			
33	.008	0.3264	1/128	.0078125	0.31875
34	.007	0.2856			
35	.005	0.2040			
36	.004	0.1632	1/256	.00390625	0.159375

UNITED STATES STANDARD GAUGE
FOR SHEET AND PLATE IRON AND STEEL

The United States Standard Gauge is a weight gauge based upon the weights per square foot in ounces avoirdupois and approximate thickness based upon 480 pounds per cubic foot. In the practical use and application of the United States Standard Gauge, a weight variation of 2½ per cent either way may be allowed.

Gauge Number	Approximate Thickness		Weight per Square Foot, Ounces, Avoirdupois	Weight per Square Foot, Pounds, Avoirdupois
	Fractional Inches	Decimal Inches		
0000000	1/2	.5	320	20.00
000000	15/32	.46875	300	18.75
00000	7/16	.4375	280	17.50
0000	13/32	.40625	260	16.25
000	3/8	.375	240	15.00
00	11/32	.34375	220	13.75
0	5/16	.3125	200	12.50
1	9/32	.28125	180	11.25
2	17/64	.265625	170	10.625
3	1/4	.25	160	10.00
4	15/64	.234375	150	9.375
5	7/32	.21875	140	8.75
6	13/64	.203125	130	8.125
7	3/16	.1875	120	7.50
8	11/64	.171875	110	6.875
9	5/32	.15625	100	6.25
10	9/64	.140625	90	5.625
11	1/8	.125	80	5.00
12	7/64	.109375	70	4.375
13	3/32	.09375	60	3.75
14	5/64	.078125	50	3.125
15	9/128	.0703125	45	2.8125
16	1/16	.0625	40	2.50
17	9/160	.05625	36	2.25
18	1/20	.05	32	2.00
19	7/160	.04375	28	1.75
20	3/80	.0375	24	1.50
21	11/320	.034375	22	1.375
22	1/32	.03125	20	1.25
23	9/320	.028125	18	1.125
24	1/40	.025	16	1.00
25	7/320	.021875	14	.875
26	3/160	.01875	12	.75
27	11/640	.0171875	11	.6875
28	1/64	.015625	10	.625
29	9/640	.0140625	9	.5625
30	1/80	.0125	8	.50
31	7/640	.0109375	7	.4375
32	13/1280	.010156 25	6½	.40625
33	3/320	.009375	6	.375
34	11/1280	.008593 75	5½	.34375
35	5/640	.0078125	5	.3125
36	9/1280	.007031 25	4½	.28125
37	17/2560	.006640625	4¼	.265625
38	1/160	.00625	4	.25

CONTENTS OF STORAGE WAREHOUSES

Material	Weights per Cubic Foot of Space, Pounds	Height of Pile, Feet	Weights per Square Foot of Floor, Pounds	Recommended Live Loads, Pounds per Square Foot
Groceries				
Canned Goods, in cases	58	6	348	
Coffee, Roasted, in bags	33	8	264	
Flour, in barrels	40	5	200	
Molasses, in barrels	48	5	240	
Rice, in bags	58	6	348	
Salt, in bags	70	5	350	250 to 300
Soap Powder, in cases	38	8	304	
Starch, in barrels	25	6	150	
Sugar, in barrels	43	5	215	
" in cases	51	6	306	
Tea, in chests	25	8	200	
Dry Goods, Cotton, Wool, Etc.				
Cotton, in bales, compressed	18	8	144	
Cotton Bleached Goods, in cases	28	8	224	
Cotton Flannel, in cases	12	8	96	
Cotton Sheeting, in cases	23	8	184	
Cotton Yarn, in cases	25	8	200	
Linen Goods, in cases	30	8	240	200 to 250
Sisal, compressed	21	8	168	
Tow, compressed	29	8	232	
Wool, in bales, compressed	48	5	240	
" " " not compressed	13	8	104	
" worsted, in cases	27	8	216	
Building Materials				
Cement, Natural	50	6	354	
" Portland	73	6	438	300 to 400
Lime and Plaster	53	5	265	
Hardware, Etc.				
Door Checks	45			
Hinges	64			
Locks, in cases, packed	31			
Sash Fasteners	48			300 to 400
Screws	101			
Sheet Tin, in boxes	278	2	556	
Wire Cables, on reels			425	
Wire, Galvanized Iron, in coils	74	4½	333	
Drugs, Paints, Oil, Etc.				
Bleaching Powder, in hogsheads	31	3½	102	
Linseed Oil, in barrels	36	6	216	
Rosin, in barrels	48	6	288	
Shellac, Gum	38	6	228	
Soda, Caustic, in iron drums	88	3-1/3	294	200 to 300
Sulphuric Acid	60	1-2/3	100	
White Lead Paste, in cans	174	3½	610	
White Lead, dry	86	4¾	408	
Red Lead and Litharge, dry	132	3¾	495	
Miscellaneous				
Glass and Chinaware, in crates	40	8	320	
Hides and Leather, in bales	20	8	160	
Paper, Newspaper, and Strawboards	35	6	210	300
Paper, Writing and Calendared	60	6	360	
Rope, in coils	32	6	192	

SPECIFIC GRAVITIES AND WEIGHTS

Substance	Specific Gravity	Weight Pounds per Cu. Ft.
Metals, Alloys, Ores		
Aluminum, cast-hammered	2.55–2.75	165
Aluminum bronze	7.7	481
Brass, cast-rolled	8.4–8.7	534
Bronze, 7.9 to 14% Sn	7.4–8.9	509
Copper, cast-rolled	8.8–9.0	556
" ore, pyritic	4.1–4.3	262
Gold, cast-hammered	19.25–19.35	1205
Iron, cast, pig	7.2	450
" wrought	7.6–7.9	485
" steel	7.8–7.9	490
" ferro-silicon	6.5–7.3	437
" ore, hematite	5.2	325
" " magnetite	4.9–5.2	315
" slag	2.5–3.0	172
Lead	11.37	710
Manganese	7.2–8.0	475
Mercury	13.6	849
Nickel	8.9–9.2	565
" metal	8.8–9.0	556
Platinum, cast-hammered	21.1–21.5	1340
Silver, cast-hammered	10.4–10.6	656
Tin, cast-hammered	7.2–7.5	459
Zinc, cast-rolled	6.9–7.2	440
Various Solids		
Cereals, oats, bulk		32
" barley "		39
" rye, "		44
" wheat, "		48
Hay and straw, bales		20
Cotton, Flax, Hemp	1.47–1.50	92
Glass	2.46–2.65	158
Ice, loose	0.484–0.50	28
Glass, common	2.40–2.60	156
Leather	0.86–1.02	59
Paper	0.70–1.15	58
Petroleum, oil of		52
Rubber	0.92–0.96	59
Salt, granulated, piled		48
Wool	1.32	82
Asphaltum	2.65–2.67	166
Sawdust	0.21	13
Timber, Seasoned		
Ash, white and red	0.638–0.64	40
Cedar, white and red	0.32–0.38	23
Chestnut	0.66	41
Fir, Douglas spruce	0.53	33
" pumpkin	0.40	25
Pine, white	0.43	27
Hemlock	0.42–0.52	29
Hickory	0.74–0.84	49
Maple, hard	0.68	43
Oak, live	0.80	50
" red, black	0.62	41
Pine, Oregon	0.55	34
Poplar	0.48	30
Spruce, white, dried	0.40–0.50	32
Walnut, black	0.62	39
Volumes Contained		
Barrel (cubic 31½ in. [0°])		
Gallon (cubic 231 in. [0°])		
Various Liquids		
Alcohol, 100%	0.79	49
Acids, muriatic 40%	1.20	75
" nitric 91%	1.50	94
" sulphuric 87%	1.80	112
Oils, vegetable	0.91–0.94	58
" mineral, lubricating	0.90–0.93	57
Water, 39° max. density	1.0	62.428
" 100°F.	0.9584	59.843
" ice	0.88–0.92	56
" snow, fresh fallen	125	8
" sea water	1.02–1.03	64
Ashlar Masonry		
Granite, syenite, gneiss	2.5–3.0	165
Limestone, marble	2.5–2.8	160
Sandstone, bluestone	2.1–2.4	140
Mortar Rubble Masonry		
Granite, syenite, gneiss	2.3–2.8	155
Limestone, marble	2.2–2.6	150
Sandstone, bluestone	2.0–2.2	130
Dry Rubble Masonry		
Granite, syenite, gneiss	1.9–2.3	130
Limestone, marble	1.9–2.1	125
Sandstone, bluestone	1.8–1.9	110
Brick Masonry		
Pressed brick	2.2–2.6	140
Common brick	1.8–2.0	120
Soft brick	1.5–1.7	100
Concrete Masonry		
1 cement, 3 sand, 5 stone, gravel	2.3–2.4	144
" slag, etc.	1.9–2.0	130
" cinder, etc.	1.5–1.7	100
Various Building Mat'l		
Ashes, coarse		40–45
Cement, powdered, loose		90
" set	2.7–3.2	180
Lime, gypsum, loose		53–64
Mortar, set	1.4–1.9	103
Slags, bank slag		67–72
" screenings		98–117
" machine slag		95
" slag sand		49–50
Earth, etc., Excavated		
Clay, dry		63
" damp, plastic		120
Clay and gravel, dry		100
Earth, dry, loose		76
" packed		95
" mud, loose		78
" " packed		96
" loam, loose		85
" " packed		95
Riprap, limestone		80–85
" sandstone		80
" shale		105
Sand, gravel, dry, loose		85–100
" " " packed		100–120
" " " wet		120–130

The specific gravities of solids and liquids refer to water at 4°C. Those of gases to air at 0°C and 760 mm. pressure. The weights per cubic foot are derived from average specific gravities, except where exact data are available. Weights are for bulk, dressed or loose material, etc.

SPECIFIC GRAVITIES AND WEIGHTS

Substance	Specific Gravity	Weight, Pounds per Cu. Ft.
Excavations in Water		
Sand or gravel		60
" " and clay		65
Clay		80
River mud		80
Soil		70
Stone riprap		65
Minerals		
Asbestos	2.1-2.8	153
Basalt	2.7-3.2	184
Borax	1.7-1.8	109
Clay, marl	1.8-2.6	137
Dolomite	2.8	181
Granite, syenite	2.5-3.1	175
Gypsum, alabaster	2.3-2.8	159
Limestone, marble	2.5-2.8	165
Magnesite	3.0	187
Pumice, natural	0.37-0.90	40
Quartz, flint	2.5-2.8	165
Sandstone, blue stone	2.2-2.5	147
Shale, slate	2.7-2.9	175
Soapstone, talc	2.6-2.8	169
Stone, Quarried, Piled		
Basalt, granite, gneiss		96
Limestone, marble, quartz		95
Sandstone		82
Stone, Quarried, Piled (Cont.)		
Shale		92
Greenstone, hornblende		107
Bituminous Substances		
Asphaltum	1.1-1.5	81
Coal, anthracite	1.4-1.7	97
" bituminous	1.2-1.5	84
" lignite	1.1-1.4	79
" peat, turf, dry	0.65-0.85	47
" charcoal, pine	0.28-0.44	23
" " oak	0.47-0.57	33
" coke	1.0-1.4	75
Graphite	1.9-2.3	131
Paraffine	0.87-0.91	56
Petroleum	0.87	54
" refined	0.79-0.82	50
" benzine	0.73-0.75	46
" gasoline	0.66-0.69	42
Pitch	1.07-1.15	69
Tar, bituminous	1.09	75
Coal and Coke, Piled		
Coal, anthracite		47-58
" bituminous, lignite		40-54
" peat, turf		20-30
" charcoal		10-14
" coke		23-32

The specific gravities of solids and liquids refer to water at 4°C., those of gases to air at 0°C. and 760 mm pressure. The weights per cubic foot are derived from average specific gravities except where stated that weights are for bulk, heaped or loose material, etc.

STRENGTH OF MATERIALS

STRESSES IN THOUSANDS OF POUNDS PER SQUARE INCH

Metals and Alloys	Stresses					Modulus of Elasticity, Pounds	Elongation, %
	Tension, Ultimate	Elastic Limit	Compression Ultimate	Bending, Ultimate	Shearing Ultimate		
Aluminum, cast	15	6–5	12	..	12	11,000,000	
" bars, sheets	24–28	12–14	..	..	..	..	
Aluminum Bronze,							
5% to 7½% Al	75	40	120	..	..	..	
10% Al	85–100	60	..	..	..	..	
Brass, cast, common	18–24	6	30	20	36	9,000,000	
" wire, hard	80	..	..	..	..	..	
" " annealed	50	16	..	..	..	14,000,000	
Bronze—							
Gun Metal, 9 Cu, 1 Sn	25–55	10	..	52	..	10,000,000	
Manganese, cast 10% Sn	60	30	125	..	..	..	
" rolled 2% Mn	100	80	..	..	..	..	
Phosphorus, cast 9% Sn	50	24	..	..	..	..	
" wire 1% P	100	..	..	..	..	..	
Bronze Tobin, cast—							
38% Zn	66						
1½% Sn	80	40	..	..	..	4,5000,00	
1/3% Pb	100						
Copper, cast	25	6	40	22	30	10,000,000	
" plates, rods, bolts	32–35	10	32	..	..	..	
" wire, annealed	36	10	..	..	..	15,000,000	
Delta Metal, cast—							
55—60% Cu	45						
38—40% Zn	68						
2— 4% Fe	85						
1— 2% Sn	100						
German Silver, 25% Zn, 20% Ni							
Iron, see next page							
Lead, cast	1–8					1,000,000	
" pipe, wire	2–2–2–5					1,000,000	
" rolled sheets	3–3					720,000	
Tin, cast	3–5–4–6	1–5–1–8	6	4		4,000,000	
" antimony, 10 Sn, 1 Sb	11						
Zinc, cast	4–6	4	18	7		13,000,000	
" rolled sheets	7–16	..	..	..	..	..	
Steel							
Shapes, Plates, Bars*							
" bridges	55–65	½ tens.	tensile	tensile	¾ tens.	29,000,000	27–3–23–0
" buildings	55–65	"	"	"	"	29,000,000	25–4–21–5
" cars	50–65	"	"	"	"	29,000,000	30–0–23–0
" locomotives	55–65	"	"	"	"	29,000,000	27–3–23–0
" ships	58–68	"	"	"	"	29,000,000	25–9–22–1
Boiler Plates*							
" " fire box	55–65	½ tens.	tensile	tensile	¾ tens.	29,000,000	27–3–23–0
" " flange plates	52–62	"	"	"	"	29,000,000	28–8–24–2
Rivets*							
" boilers	45–55	½ tens.	tensile	tensile	¾ tens.	29,000,000	33–3–27–3
" bridges	46–56	"	"	"	"	29,000,000	32–6–26–8
" buildings	46–56	"	"	"	"	29,000,000	30–4–25–0
" cars	48–58	"	"	"	"	29,000,000	31–3–25–9
" ships	55–65	"	"	"	"	29,000,000	27–3–23–0
Concrete Bars*							
" plain, structural grade	55–70	33	tensile	tensile	¾ tens.	29,000,000	25–4–20–0
" " intermediate	70–85	40	"	"	"	29,000,000	18–6–15–3
" " hard	80	50	"	"	"	29,000,000	15–0
" deformed, struc'l grade	55–70	33	"	"	"	29,000,000	22–7–17–9
" " intermediate	70–85	40	"	"	"	29,000,000	16–1–13–2
" " hard	80	50	"	"	"	29,000,000	12–5
" cold twisted	..	55	"	"	"	29,000,000	5–0
Castings*							
" soft	60	27	tensile	tensile	¾ tens.	29,000,000	22–0
" medium	70	31–5	"	"	"	29,000,000	18–0
" hard	80	36	"	"	"	29,000,000	15–0
Forgings*	..	..	..	..	..	..	..

*See Specifications of the Society of Testing Materials.

STRENGTH OF MATERIALS

STRESSES IN THOUSANDS OF POUNDS PER SQUARE INCH

Metals and Alloys	Stresses					Modulus of Elasticity, Pounds	Elongation, %
	Tension, Ultimate	Elastic Limit	Compression, Ultimate	Bending, Ultimate	Shearing, Ultimate		
Steel Alloys							
Nickel Steel,* 3.25% Ni							
" shapes, plates, bars	85–100	50	tensile	tensile	½ tens.	29,000,000	17 6–15 0
" rivets	70–80	45	"	"	"	29,000,000	21 4–18 8
" eye bars, unannealed	95–110	55	"	"	"	29,000,000	15 8–13 6
" " " annealed	90–105	52	"	"	"	29,000,000	20 0
Copper Steel, 0.50% Cu	60–68	37 38	"	"	"	30,000,000	29 0–25 0
Steel Springs and Wire							
Springs, untempered	95–110	40 70					
Wire, unannealed	120	60					
" annealed	80	40					
" bridge cable	200	95					
Wrought Iron							
Shapes	48	26	tensile	tensile	⅔ tens.	28,000,000	
Bars	50	27	"	"	"	28,000,000	
Wire, unannealed	80					15,000,000	
" annealed	60	27				25,000,000	
Cast Iron							
Common	15–18	8	80	30	18–20	12,000,000	
Gray	18–24			25–32			
Malleable	27–35	15–20	46	30	40		

STRESSES IN POUNDS PER SQUARE INCH

Building Materials	Ultimate Average Stresses			Modulus of Elasticity	Safe Working Stresses		
	Compression	Tension	Bending		Compression	Bearing	Shearing
Stone							
Blue Stone	12,000	1,200	2,500	7,000,000	1,200	1,200	500
Granite, gneiss	12,000	1,200	1,600	7,000,000	1,200	1,200	500
Limestone, marble	8,000	800	1,500	7,000,000	800	800	150
Sandstone	5,000	150	1,200	3,000,000	600	600	150
Slate	10,000	3,000	5,000	14,000,000	1,000	1,000	175
Brick							
Common, good	10,000	200					
" medium burned	13,000						
" hard burned	15,000						
Pressed and paving	6,000						
Cement, Portland							
Neat, 28 days	7,000	740					
" 90 days	7,350	740					
1:3 Sand, 28 days	1,200	320					
" 90 days	1,400	340					
Masonry							
Granite					120	600	
Limestone, bluestone					800	400	
Sandstone					280	400	
Rubble					140	250	
" coursed					160	240	
Concrete, P.C., 1 2 4					500	600	
" " 1 2½ 5					280	400	
Brick, common					160	320	
" hard burned					240	500	
Miscellaneous							
Glass, common	10,000	3,000	3,000	8,000,000			
" flooring	10,000	3,000	3,000				
Plaster	700	70					
Terra cotta	5,000						
Ropes, rope steel hoisting		80,000					
" standing, derrick		70,000					
" guys		8,000					
Belts, solid woven, cotton		7,200					
" " " flax		9,000					

*See Specifications of the Society of Testing Materials.

EXPANSION OF BODIES BY HEAT

The linear coefficient of expansion of a body is the rate at which the unit of length changes, under constant pressure, with an increase of unit or one degree of temperature; the square surface coefficient of expansion is, approximately, two times, and the cubical or volumetric coefficient three times the linear coefficient of expansion. A bar, if not fixed, undergoes a change in length = ltn, where l is the length of the bar in inches, t the number of degrees, n the corresponding linear coefficient; if fixed at both ends, the internal stress per unit of area = tnE, pounds per square inch, where E is the modulus of elasticity, and the total temperature stress = AtnE, pounds, where A is the cross section of the bar in square inches.

To find the increase of a bar due to an increase in temperature, from the table, multiply the length of the bar by the increase in degrees and by the coefficient for 100 degrees, and divide by 100.

COEFFICIENTS OF EXPANSION FOR 100 DEGREES = 100n

Substance	Linear Expansion		Substance	Linear Expansion	
	Centigrade	Fahrenheit		Centigrade	Fahrenheit
Metals and Alloys			**Stone and Masonry**		
Aluminum, wrought	.00231	.00128	Ashlar masonry	.00063	.00035
Brass	.00188	.00104	Brick masonry	.00055	.00031
" wire	.00193	.00107	Cement, Portland	.00107	.00059
Bronze	.00181	.00101	Concrete	.00143	.00079
Copper	.00168	.00093	" masonry	.00120	.00067
German Silver	.00183	.00102	Granite	.00084	.00047
Gold	.00150	.00083	Limestone	.00080	.00044
Iron, cast, gray	.00106	.00059	Marble	.00100	.00056
" wrought	.00120	.00067	Plaster	.00166	.00092
" wire	.00124	.00069	Rubble masonry	.00063	.00035
Lead	.00286	.00159	Sandstone	.00110	.00061
Nickel	.00126	.00070	Slate	.00104	.00058
Platinum	.00090	.00050	**Timber**		
Platinum-Iridium, 15% Ir	.00081	.00045	Fir | parallel to	.00037	.00021
Silver	.00192	.00107	Maple | parallel to	.00064	.00036
Steel, cast	.00110	.00061	Oak | fibre	.00049	.00027
" hard	.00132	.00073	Pine |	.00054	.00030
" medium	.00120	.00067	Fir |	.0058	.0032
" soft	.00110	.00061	Maple | perpendicular	.0048	.0027
Tin	.00210	.00117	Oak | to fiber	.0054	.0030
Zinc, rolled	.00311	.00173	Pine |	.0034	.0019
Miscellaneous Solids			**Liquid Substances**	Volumetric Expansion	
Glass	.00085	.00047	Alcohol	.104	.058
Graphite	.00079	.00044	Acid, nitric	.110	.061
Gutta-percha	.05980	.03322	" sulphuric	.063	.035
Paraffin	.02785	.01547	Mercury	.018	.010
Porcelain	.00036	.00020	Oil, turpentine	.090	.050

EXPANSION OF WATER, MAXIMUM DENSITY = 1

C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume
0	1.000126	10	1.000257	30	1.004234	50	1.011877	70	1.022384	90	1.035829
4	1.000000	20	1.001732	40	1.007627	60	1.016954	80	1.029003	100	1.043116

DECIMALS OF AN INCH AND OF A FOOT

Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions
64ths			64ths			64ths			64ths		
	.0052	1/16		.2552	3 1/16		.5052	6 1/16		.7552	9 1/16
	.0104	1/8		.2604	3 1/8		.5104	6 1/8		.7604	9 1/8
1	.015625	3/16	17	.265625	3 3/16	33	.515625	6 3/16	49	.765625	9 3/16
	.0208	1/4		.2708	3 1/4		.5208	6 1/4		.7708	9 1/4
	.0260	5/16		.2760	3 5/16		.5260	6 5/16		.7760	9 5/16
2	.03125	3/8	18	.28125	3 3/8	34	.53125	6 3/8	50	.78125	9 3/8
	.0365	7/16		.2865	3 7/16		.5365	6 7/16		.7865	9 7/16
	.0417	1/2		.2917	3 1/2		.5417	6 1/2		.7917	9 1/2
3	.046875	9/16	19	.296875	3 9/16	35	.546875	6 9/16	51	.796875	9 9/16
	.0521	5/8		.3021	3 5/8		.5521	6 5/8		.8021	9 5/8
	.0573	11/16		.3073	3 11/16		.5573	6 11/16		.8073	9 11/16
4	.0625	3/4	20	.3125	3 3/4	36	.5625	6 3/4	52	.8125	9 3/4
	.0677	13/16		.3177	3 13/16		.5677	6 13/16		.8177	9 13/16
	.0729	7/8		.3229	3 7/8		.5729	6 7/8		.8229	9 7/8
5	.078125	15/16	21	.328125	3 15/16	37	.578125	6 15/16	53	.828125	9 15/16
	.0833	1		.3333	4		.5833	7		.8333	10
	.0885	1 1/16		.3385	4 1/16		.5885	7 1/16		.8385	10 1/16
6	.09375	1 1/8	22	.34375	4 1/8	38	.59375	7 1/8	54	.84375	10 1/8
	.0990	1 3/16		.3490	4 3/16		.5990	7 3/16		.8490	10 3/16
	.1042	1 1/4		.3542	4 1/4		.6042	7 1/4		.8542	10 1/4
7	.109375	1 5/16	23	.359375	4 5/16	39	.609375	7 5/16	55	.859375	10 5/16
	.1146	1 3/8		.3646	4 3/8		.6146	7 3/8		.8646	10 3/8
	.1198	1 7/16		.3698	4 7/16		.6198	7 7/16		.8698	10 7/16
8	.1250	1 1/2	24	.3750	4 1/2	40	.6250	7 1/2	56	.8750	10 1/2
	.1302	1 5/8		.3802	4 5/8		.6302	7 5/8		.8802	10 5/8
	.1354	1 9/16		.3854	4 9/16		.6354	7 9/16		.8854	10 9/16
9	.140625	1 11/16	25	.390625	4 11/16	41	.640625	7 11/16	57	.890625	10 11/16
	.1458	1 3/4		.3958	4 3/4		.6458	7 3/4		.8958	10 3/4
	.1510	1 13/16		.4010	4 13/16		.6510	7 13/16		.9010	10 13/16
10	.15625	1 7/8	26	.40625	4 7/8	42	.65625	7 7/8	58	.90625	10 7/8
	.1615	1 15/16		.4115	4 15/16		.6615	7 15/16		.9115	10 15/16
	.1667	2		.4167	5		.6667	8		.9167	11
11	.171875	2 1/16	27	.421875	5 1/16	43	.671875	8 1/16	59	.921875	11 1/16
	.1771	2 1/8		.4271	5 1/8		.6771	8 1/8		.9271	11 1/8
	.1823	2 3/16		.4323	5 3/16		.6823	8 3/16		.9323	11 3/16
12	.1875	2 1/4	28	.4375	5 1/4	44	.6875	8 1/4	60	.9375	11 1/4
	.1927	2 5/16		.4427	5 5/16		.6927	8 5/16		.9427	11 5/16
	.1979	2 3/8		.4479	5 3/8		.6979	8 3/8		.9479	11 3/8
13	.203125	2 7/16	29	.453125	5 7/16	45	.703125	8 7/16	61	.953125	11 7/16
	.2083	2 1/2		.4583	5 1/2		.7083	8 1/2		.9583	11 1/2
	.2135	2 9/16		.4635	5 9/16		.7135	8 9/16		.9635	11 9/16
14	.21875	2 5/8	30	.46875	5 5/8	46	.71875	8 5/8	62	.96875	11 5/8
	.2240	2 11/16		.4740	5 11/16		.7240	8 11/16		.9740	11 11/16
	.2292	2 3/4		.4792	5 3/4		.7292	8 3/4		.9792	11 3/4
15	.234375	2 13/16	31	.484375	5 13/16	47	.734375	8 13/16	63	.984375	11 13/16
	.2396	2 7/8		.4896	5 7/8		.7396	8 7/8		.9896	11 7/8
	.2448	2 15/16		.4948	5 15/16		.7448	8 15/16		.9948	11 15/16
16	.2500	3	32	.5000	6	48	.7500	9	64	1.0000	12

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MEMORANDA